Internal | Commbustion Engine and Control

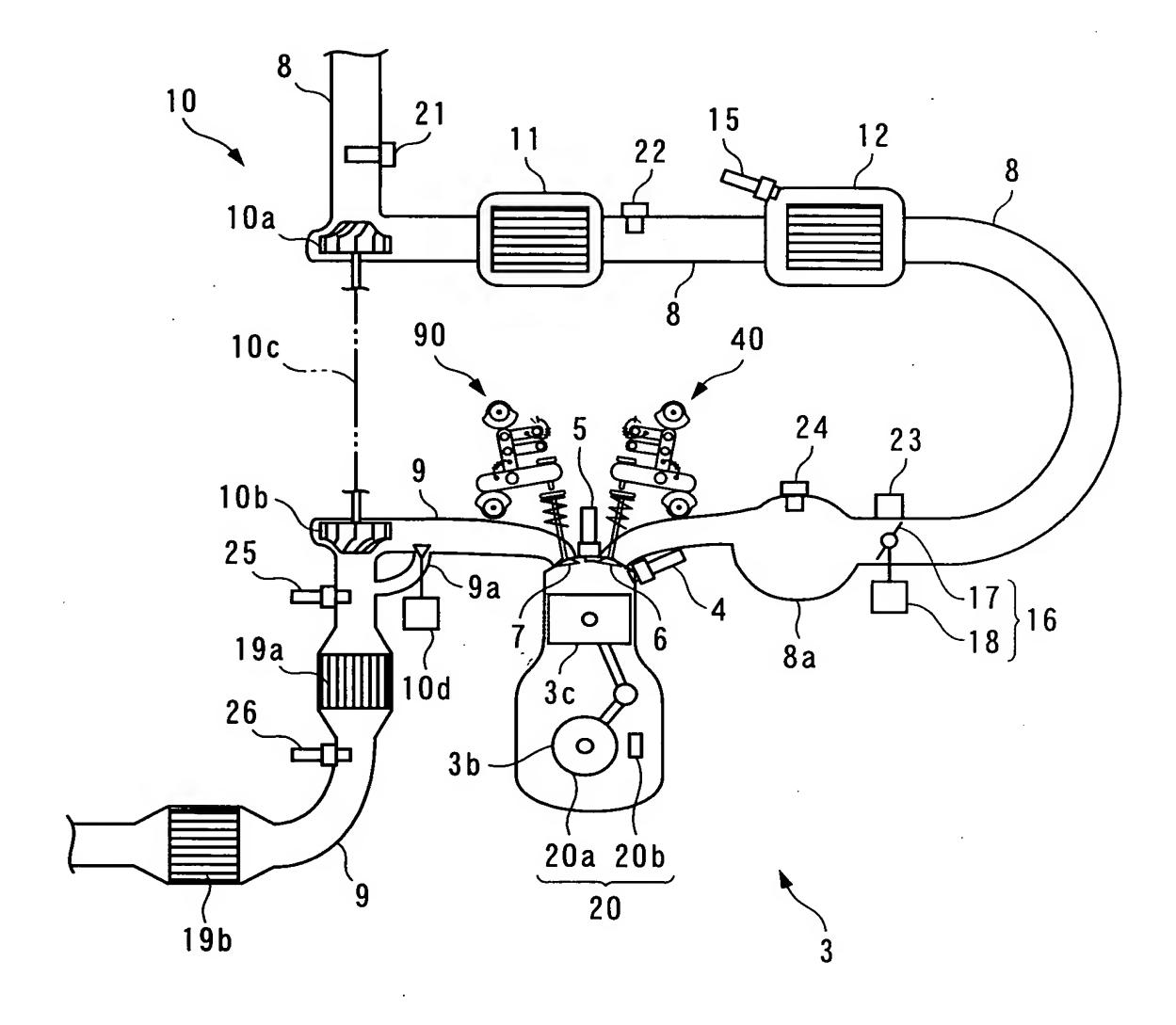
System

H 0 3-- 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(1/54)

F I G. 1



Internal IComnbustion Engine and Control

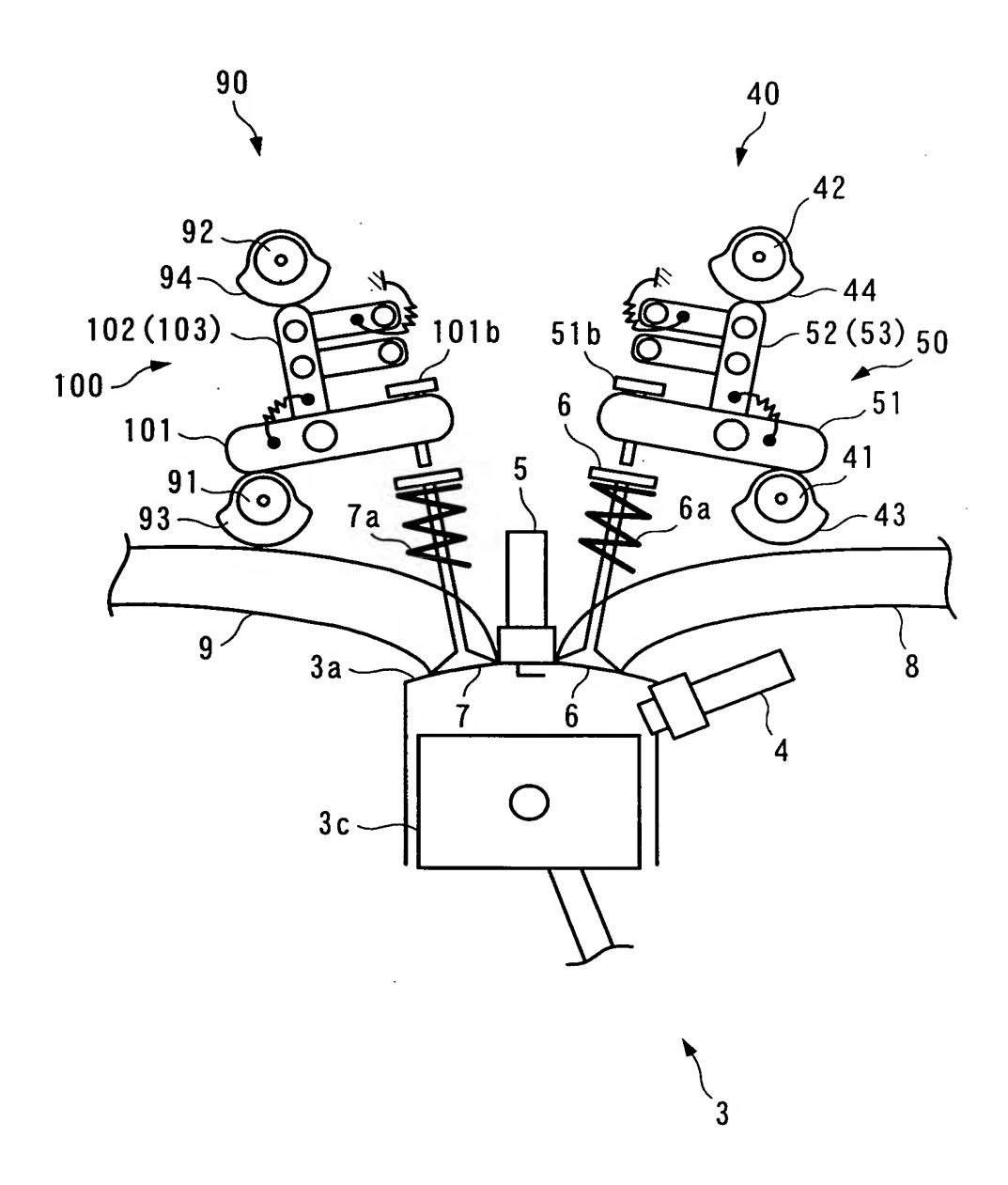
System

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Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(2/54)

F | G. 2



Internal IComnbustion Engine and Control

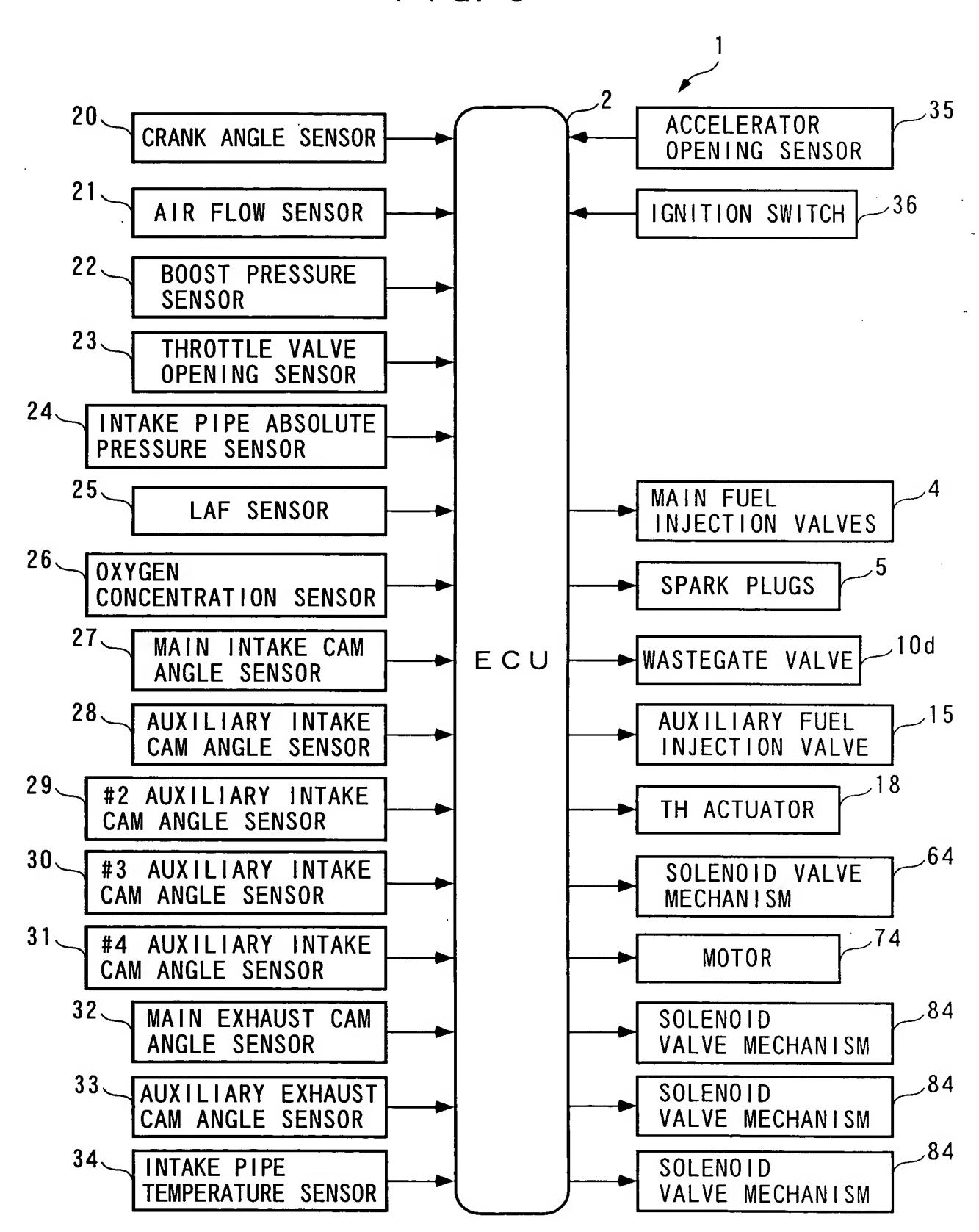
System
Inventor: YASUI, et al.

Appln. No.: New Application

Docket No.: 108419-00076

(3 / 5 4)

F | G. 3



Internal | Compustion Engine and Control

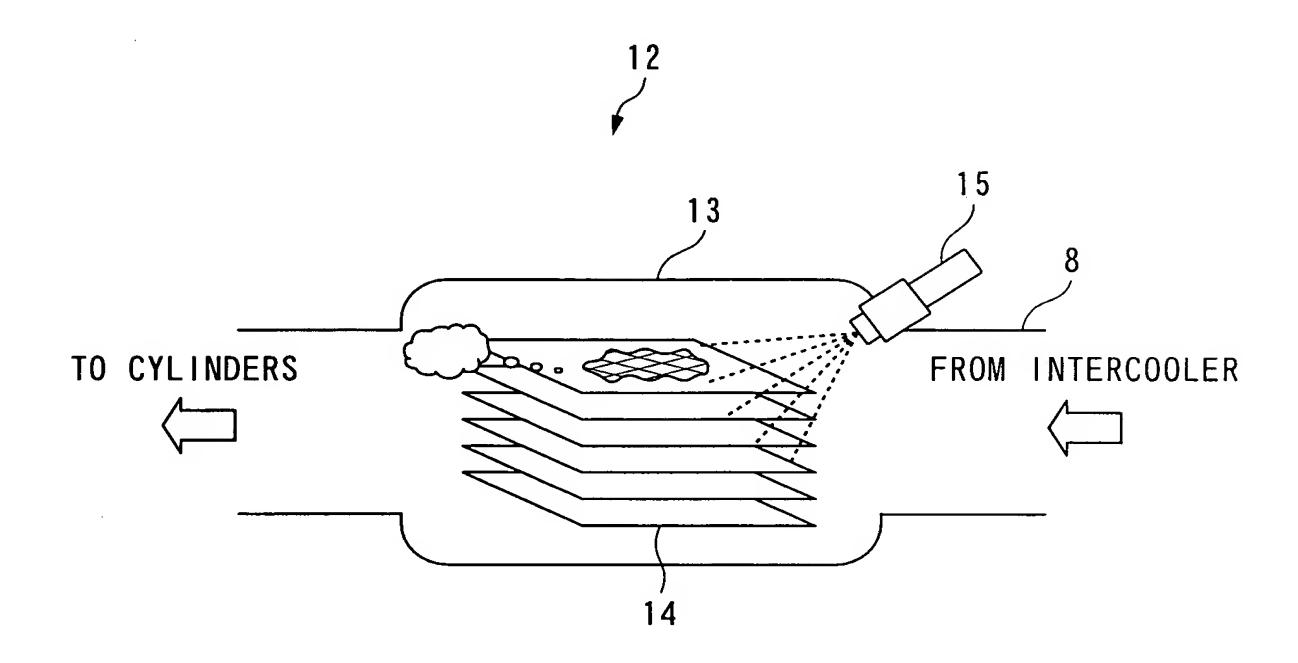
System

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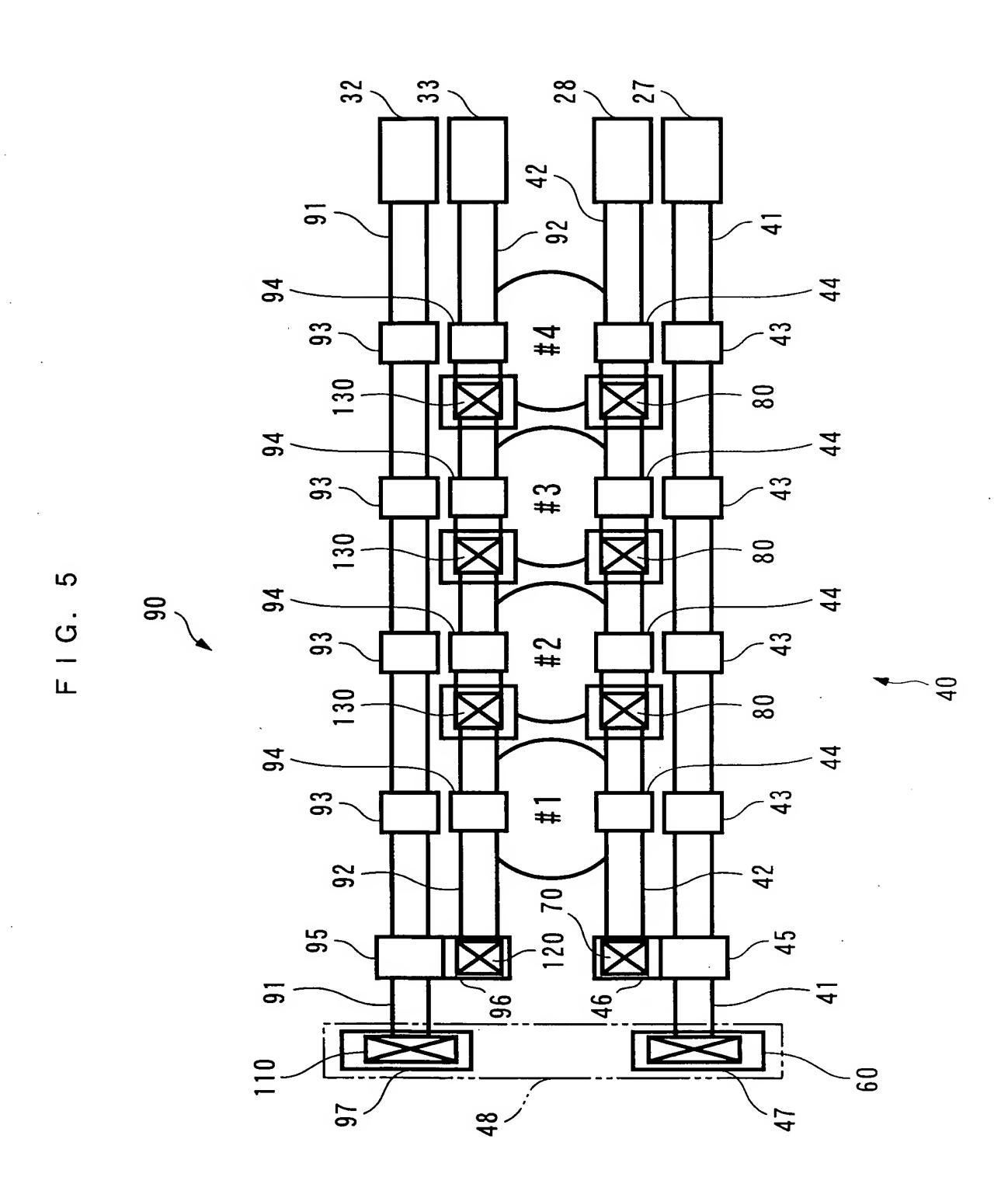
Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(4 / 5 4)

F | G. 4



H 0 3 - 1 2 6 8

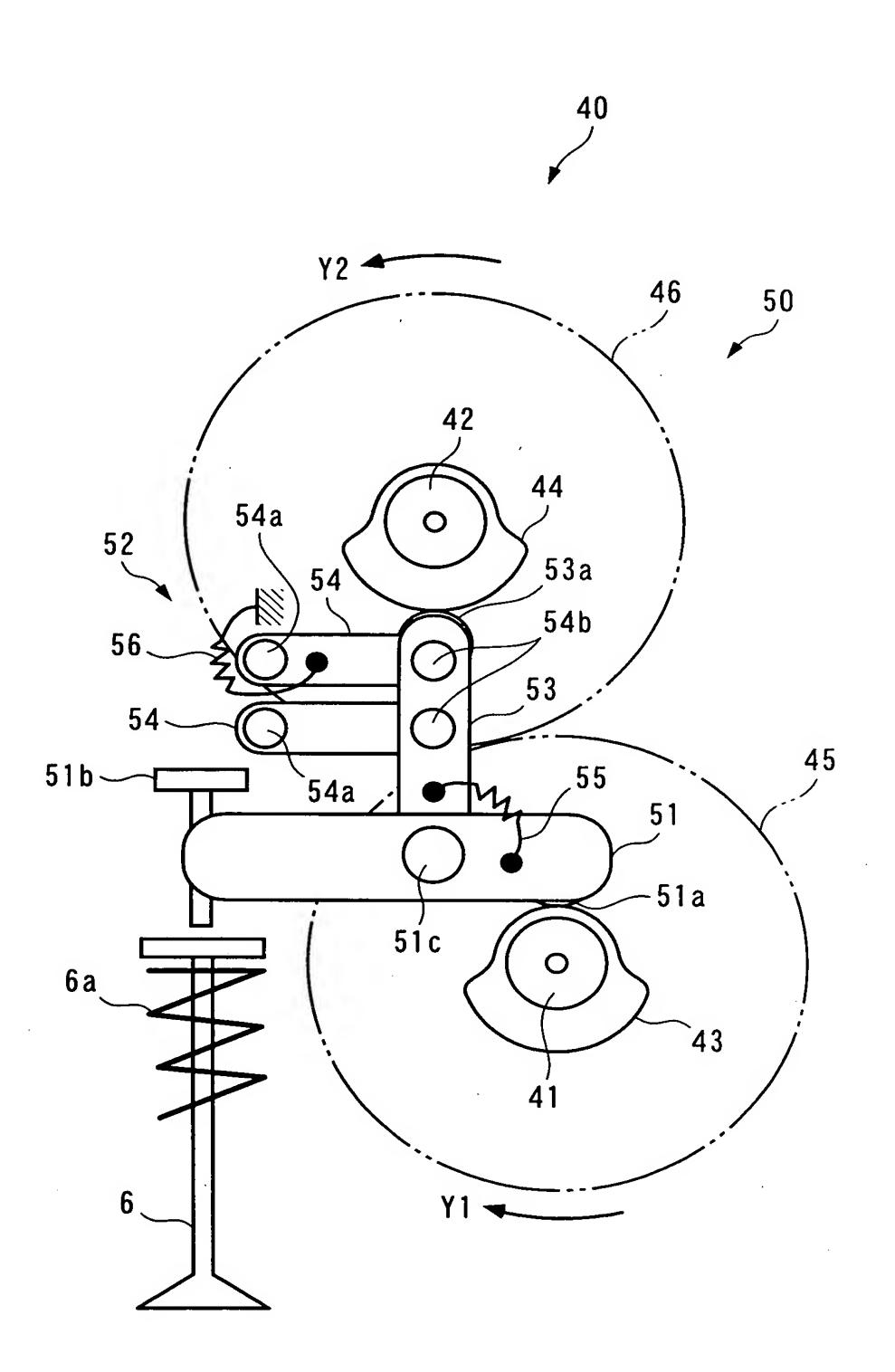


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Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(6/54)

F I G. 6

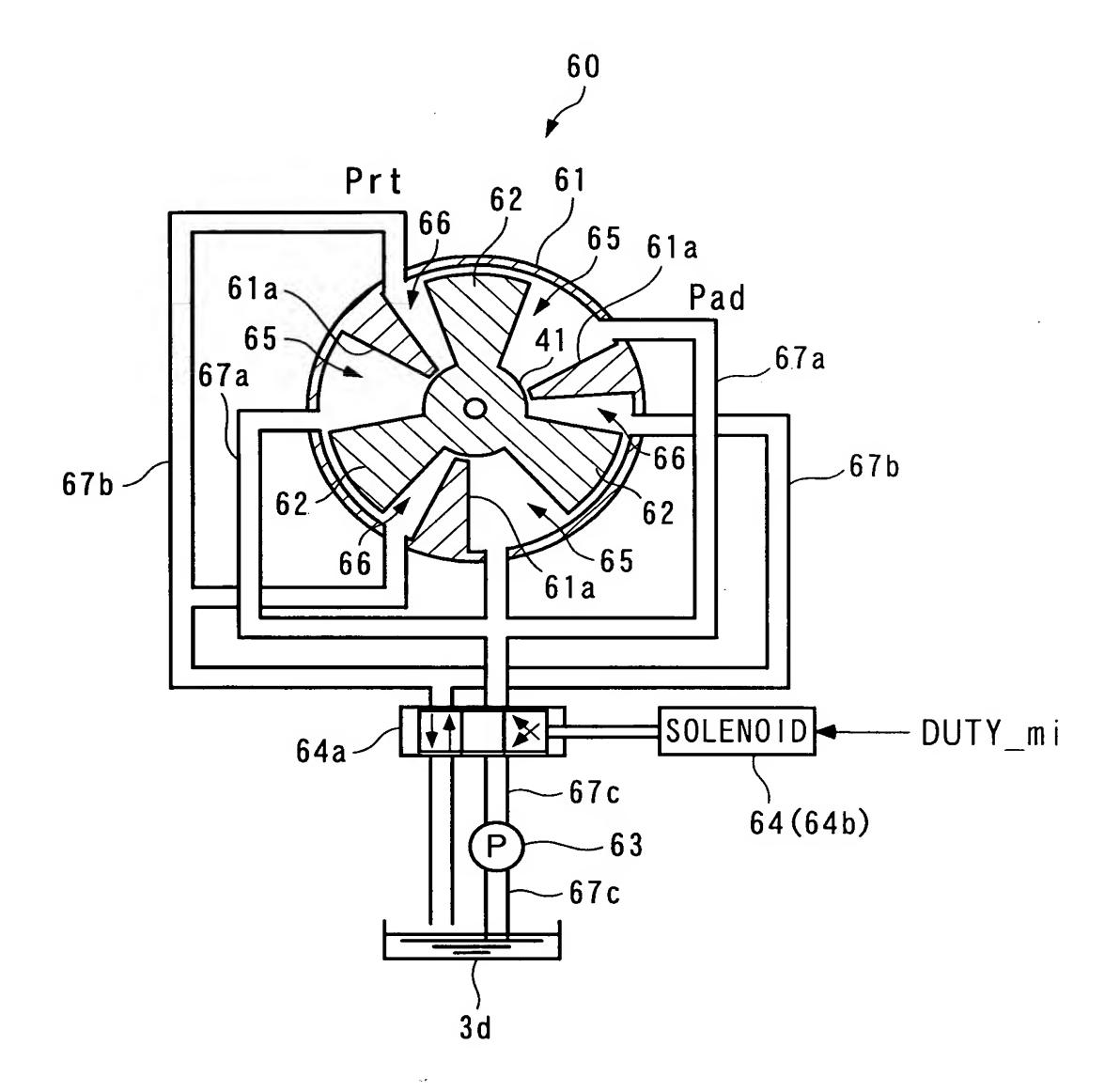


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(7/54)

F I G. 7



Internal | Commbustion Engine and Control

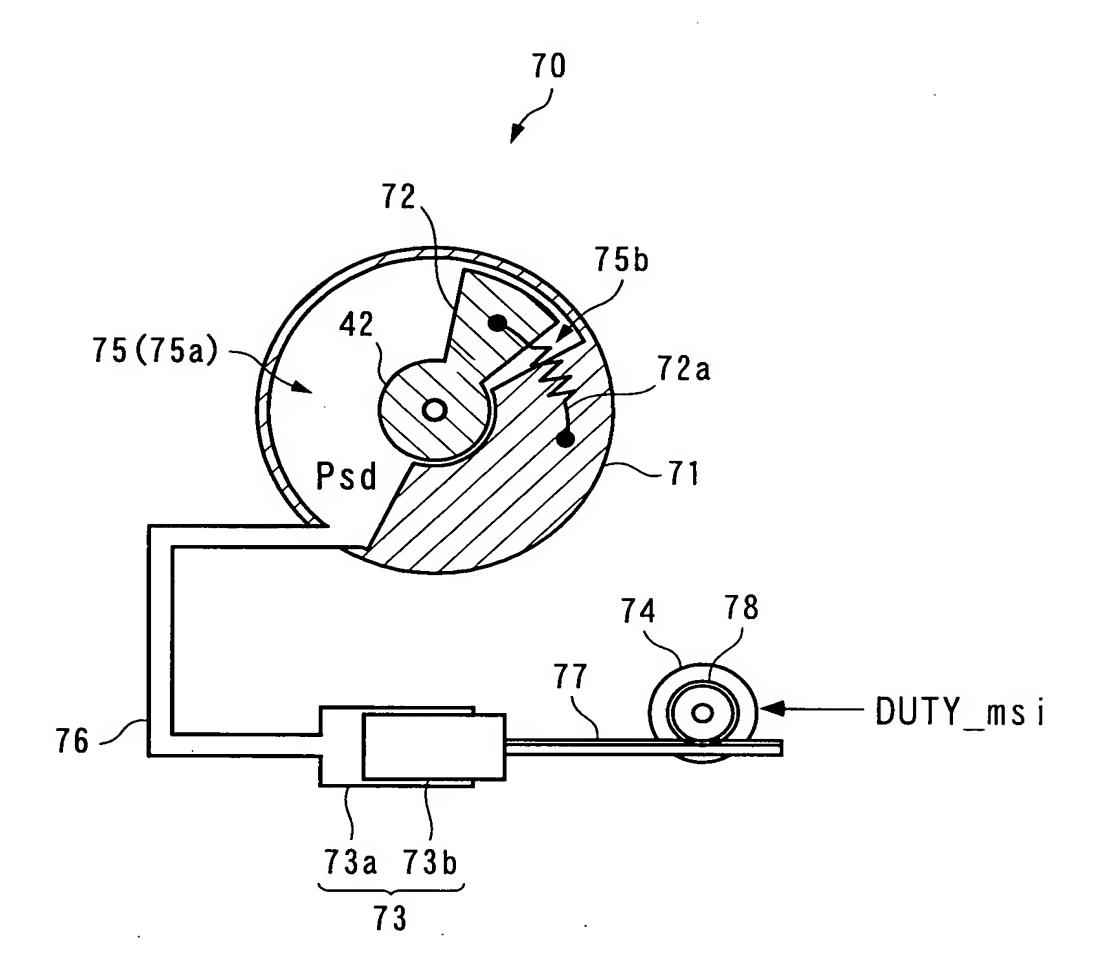
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(8/54)

F I G. 8



Internal IComnbustion Engine and Control

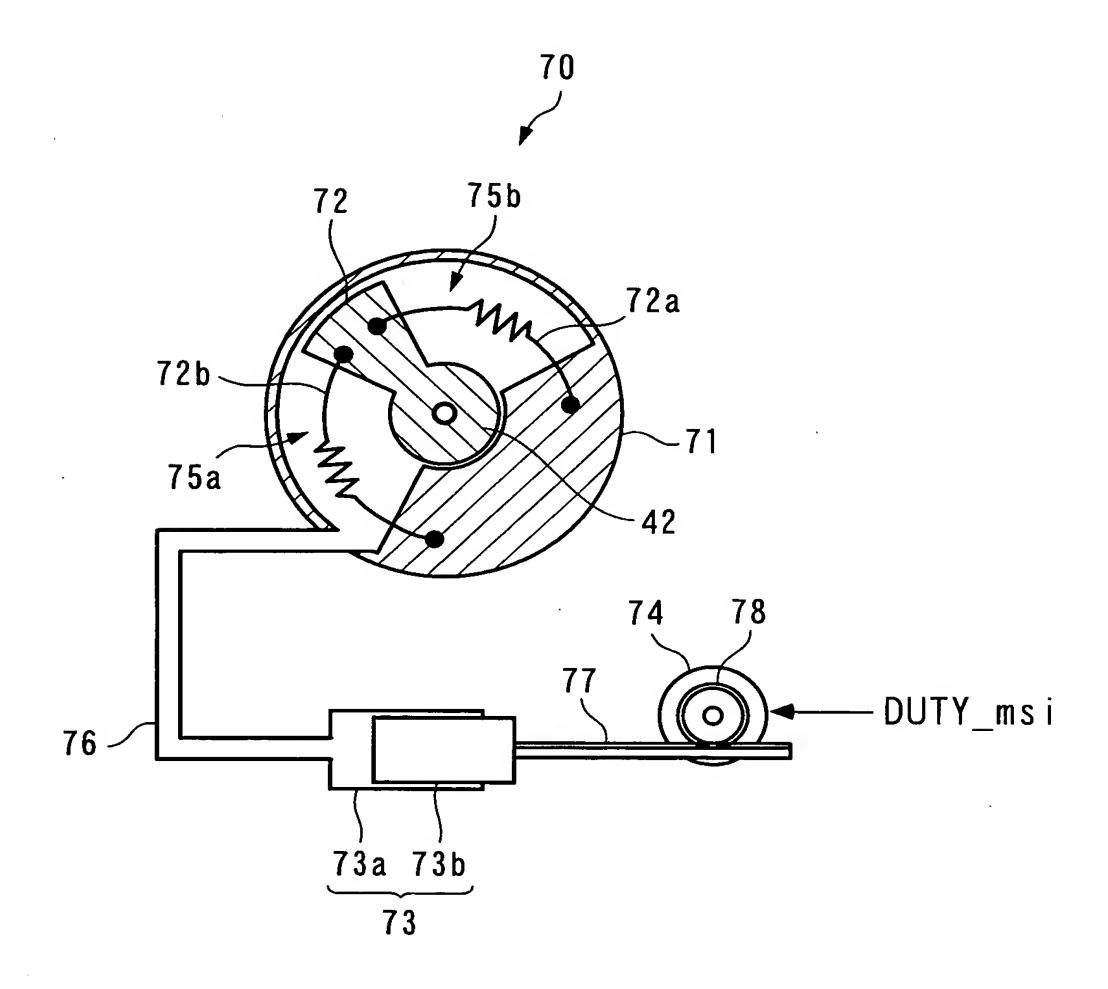
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(9/54)

F I G. 9

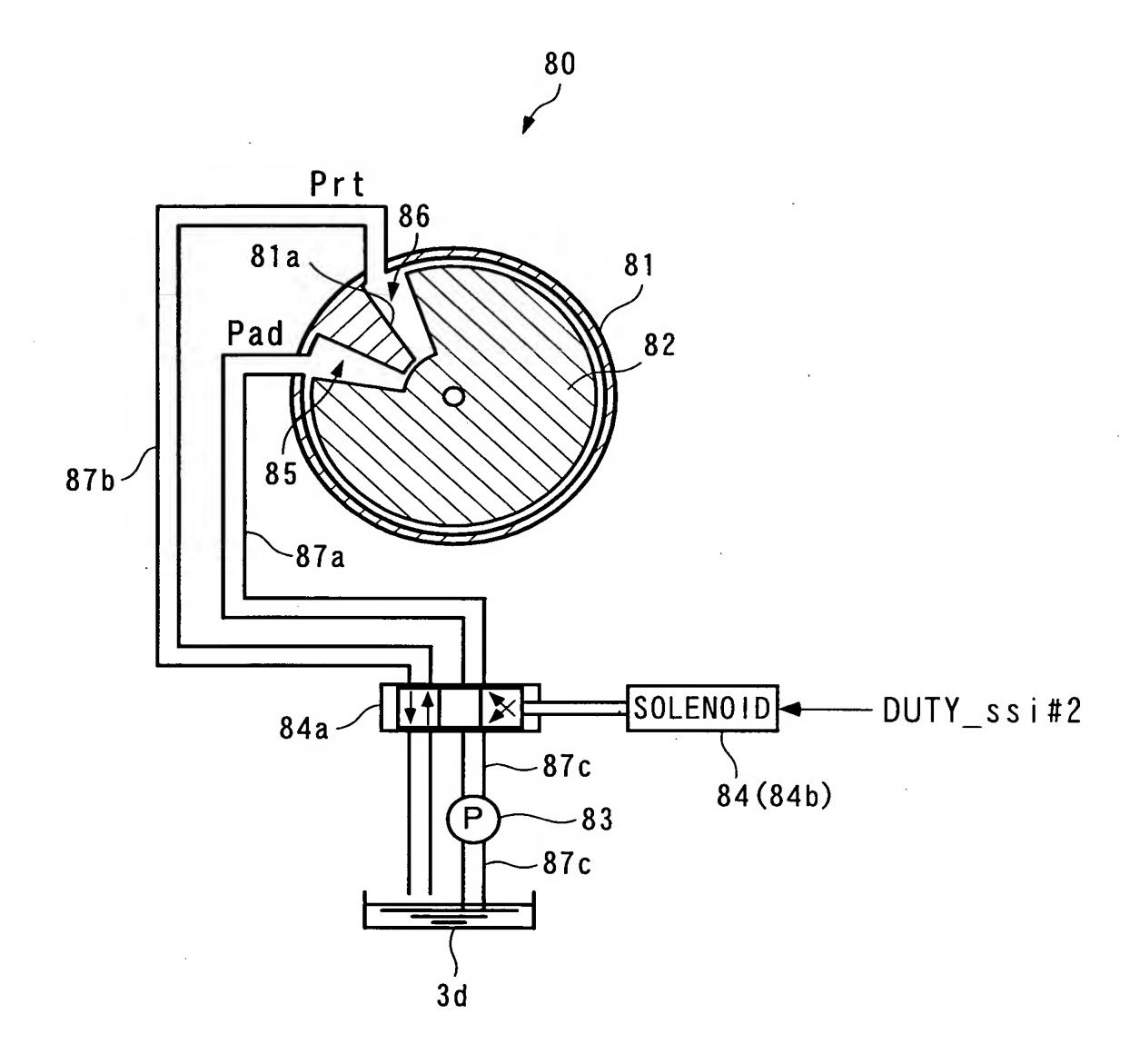


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(10/54)

F I G. 10

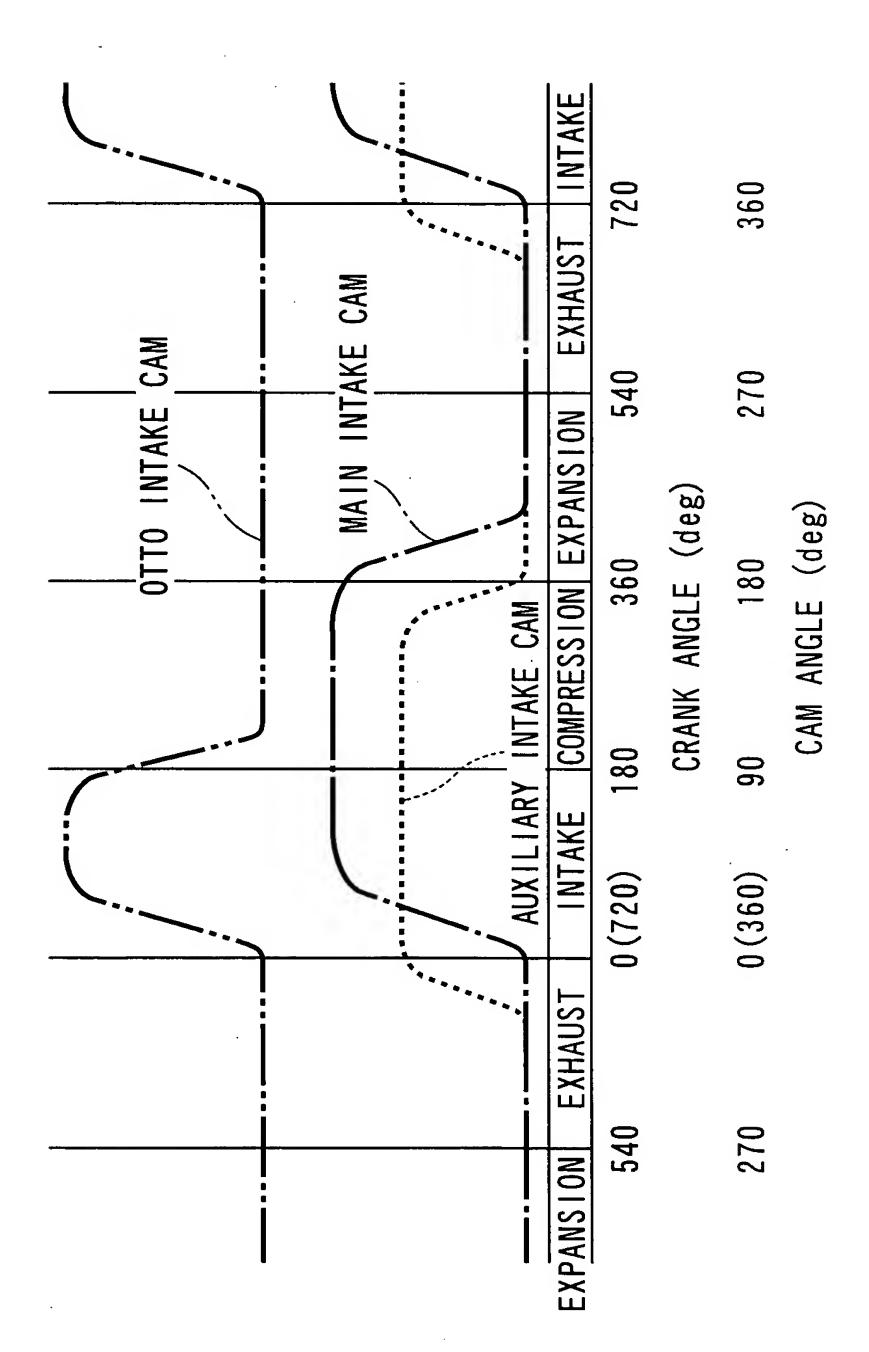


(11/54)

System

Inventor: YASUI, et al.
Appln. No.: New Application
Docket No.: 108419-00076

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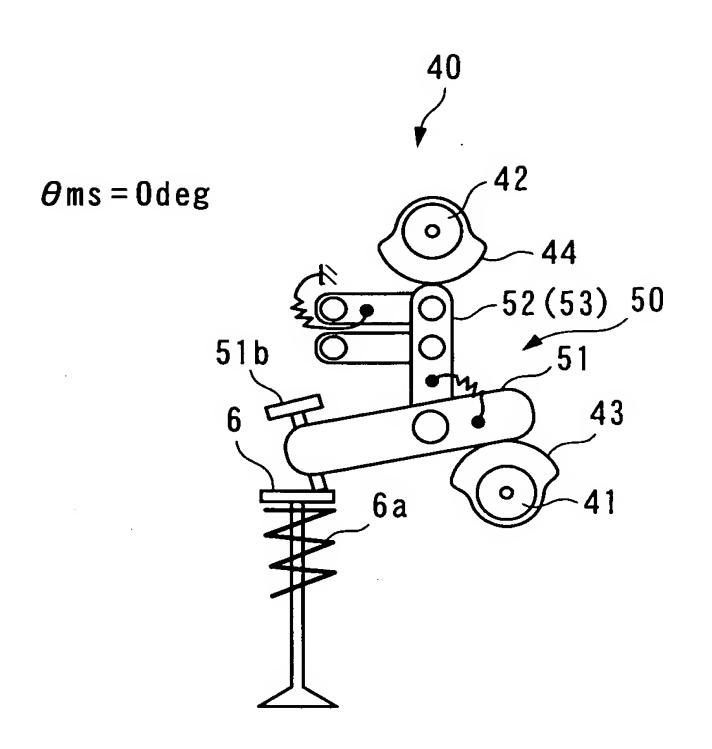


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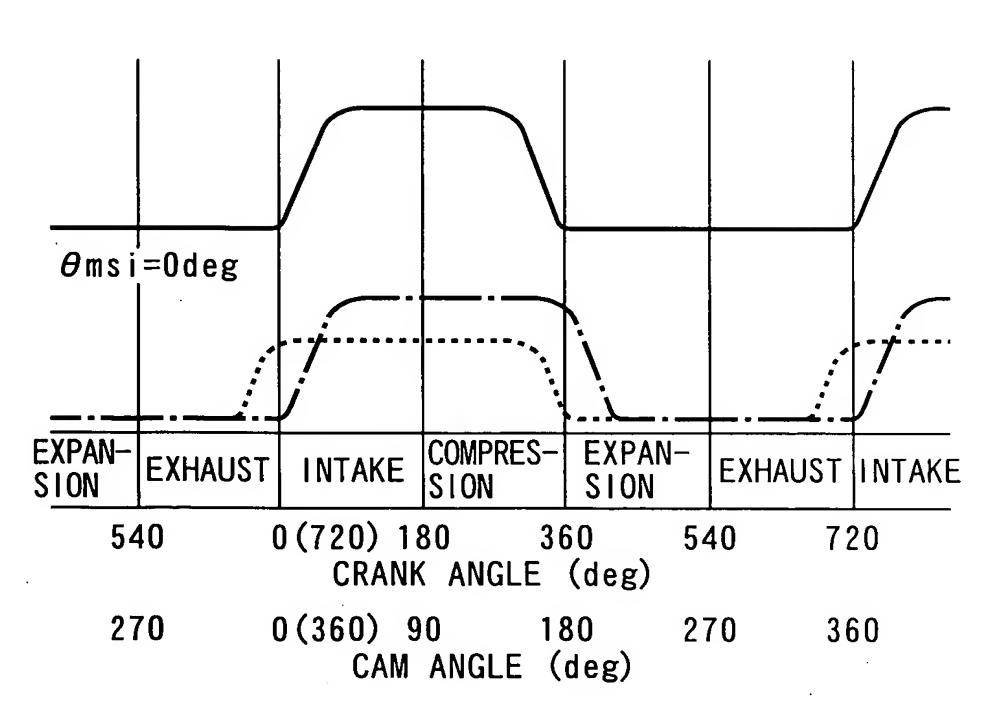
Inventor: YASUI, et al.
Appln. No.: New Application
Docket No.: 108419-00076

(12/54)

F I G. 12A



F I G. 12B

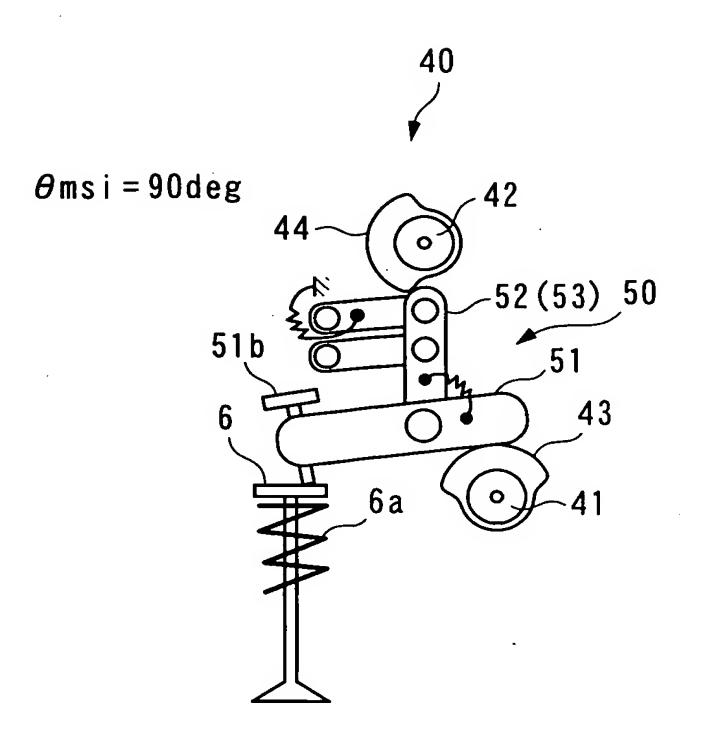


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(13/54)

F I G. 13A



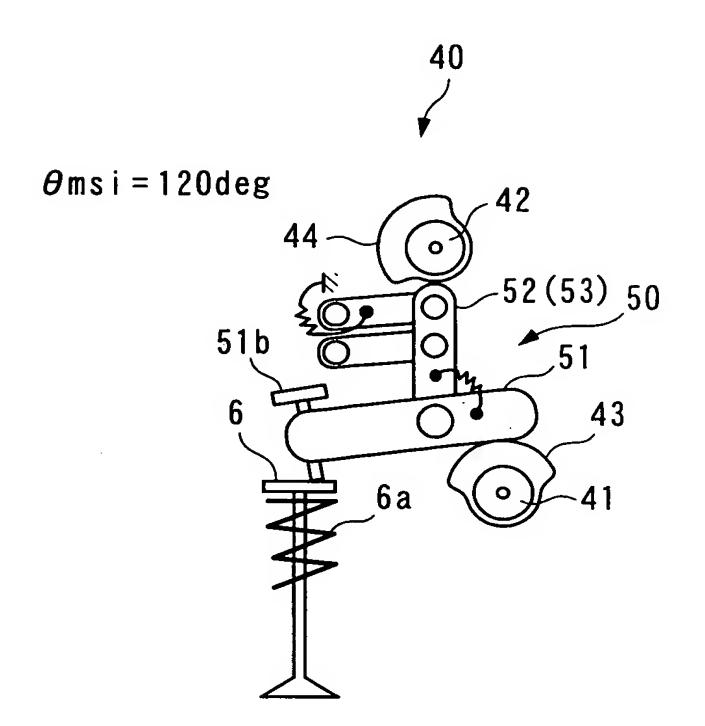
F I G. 13B θ msi = 90deg EXPAN-SION COMPRES-SION EXPAN-EXHAUST INTAKE EXHAUST INTAKE SION 540 0 (720) 180 360 540 720 CRANK ANGLE (deg) 270 0(360) 90 180 360 270 CAM ANGLE (deg)

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(14/54)

F I G. 14A



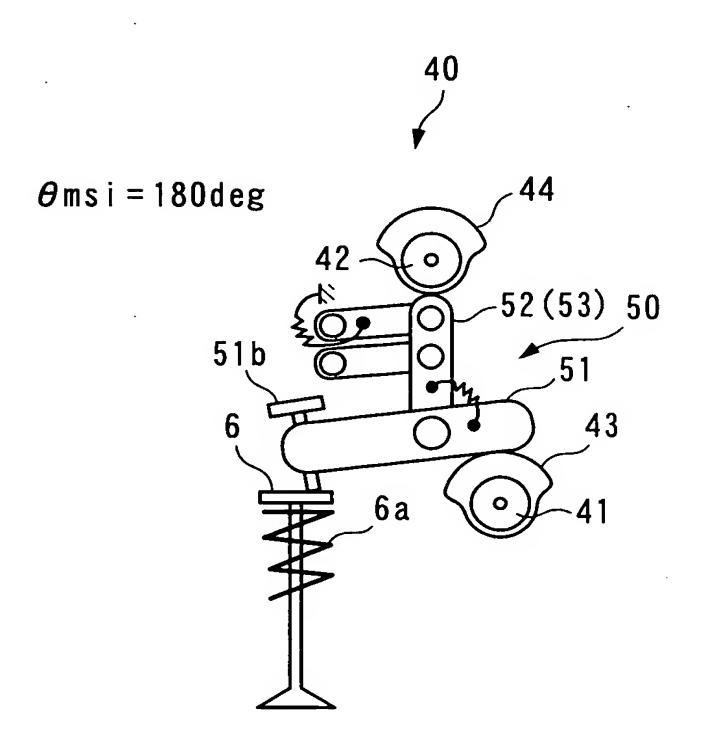
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H 0 3 - 1 2 6 8

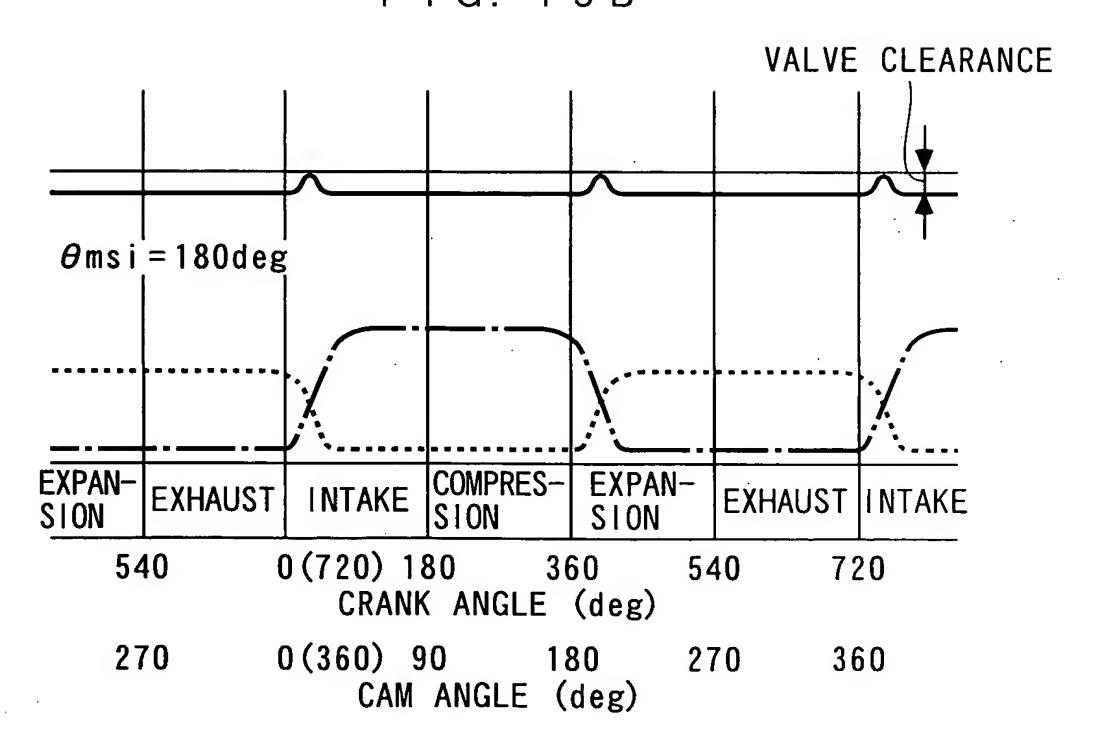
Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(15/54)

F I G. 15A



F I G. 15B



Internal IComnbustion Engine and Control

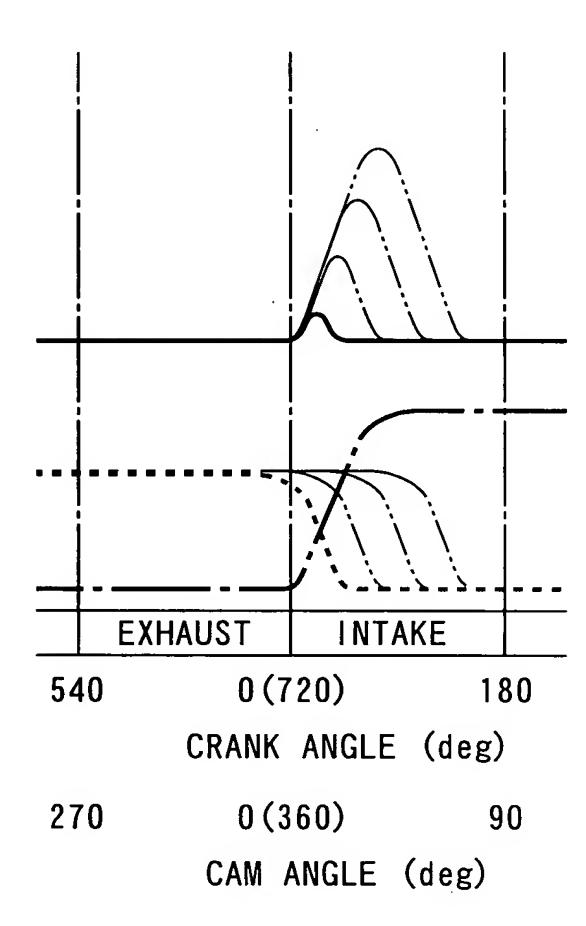
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(16/54)

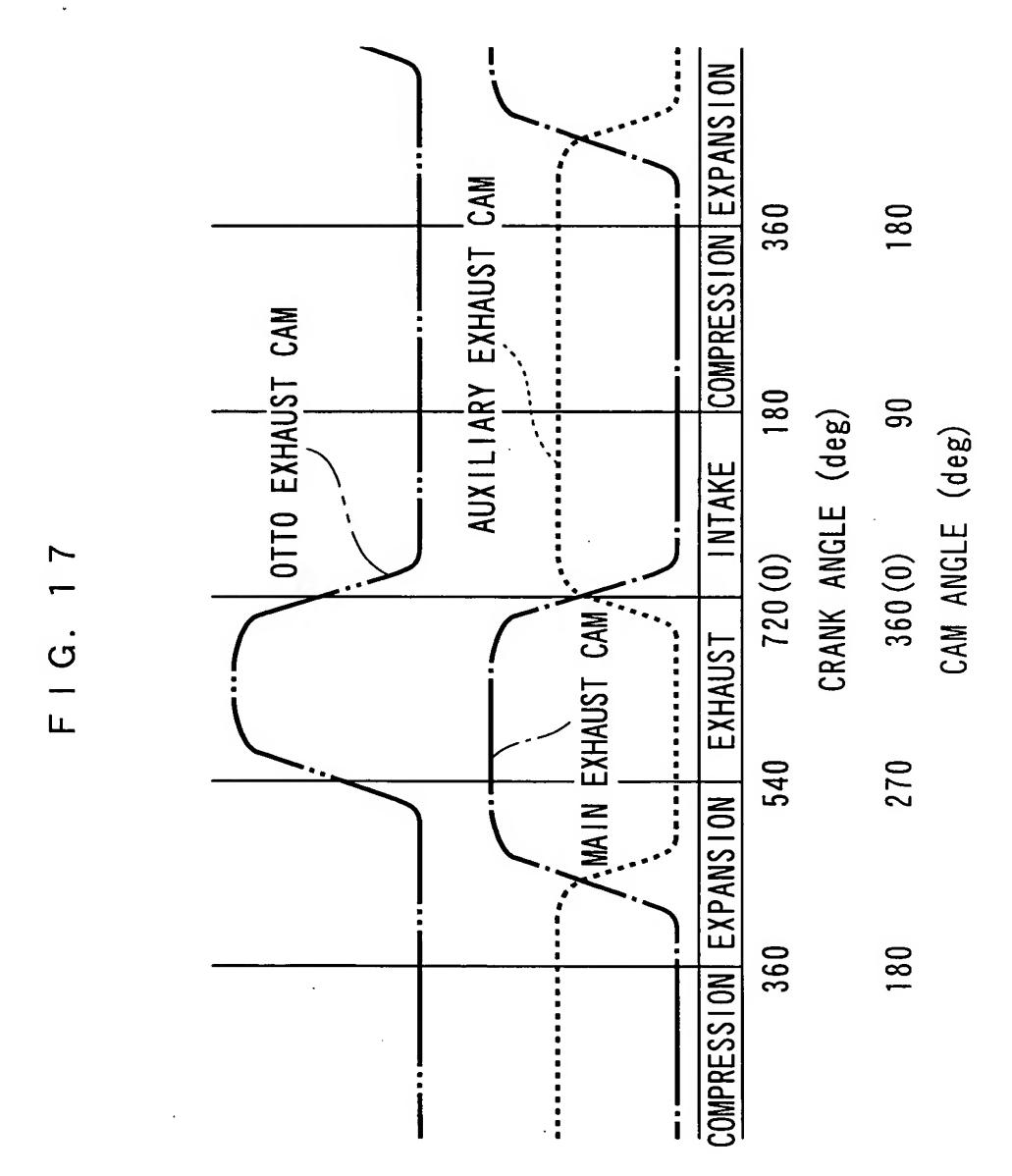
F I G. 16



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(17/54)

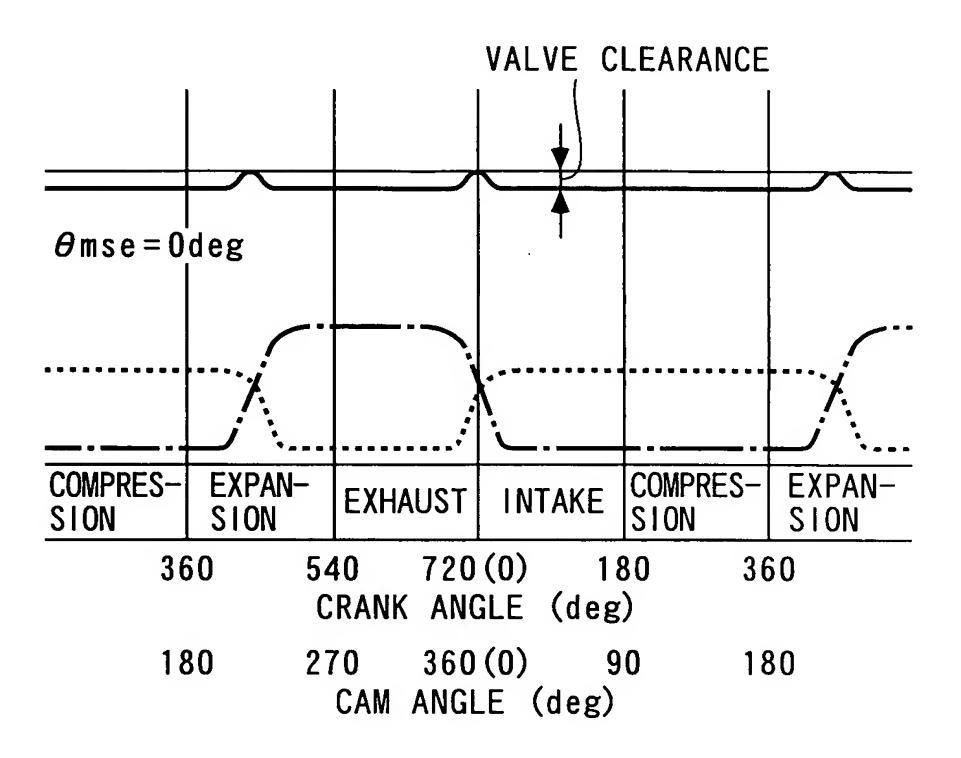


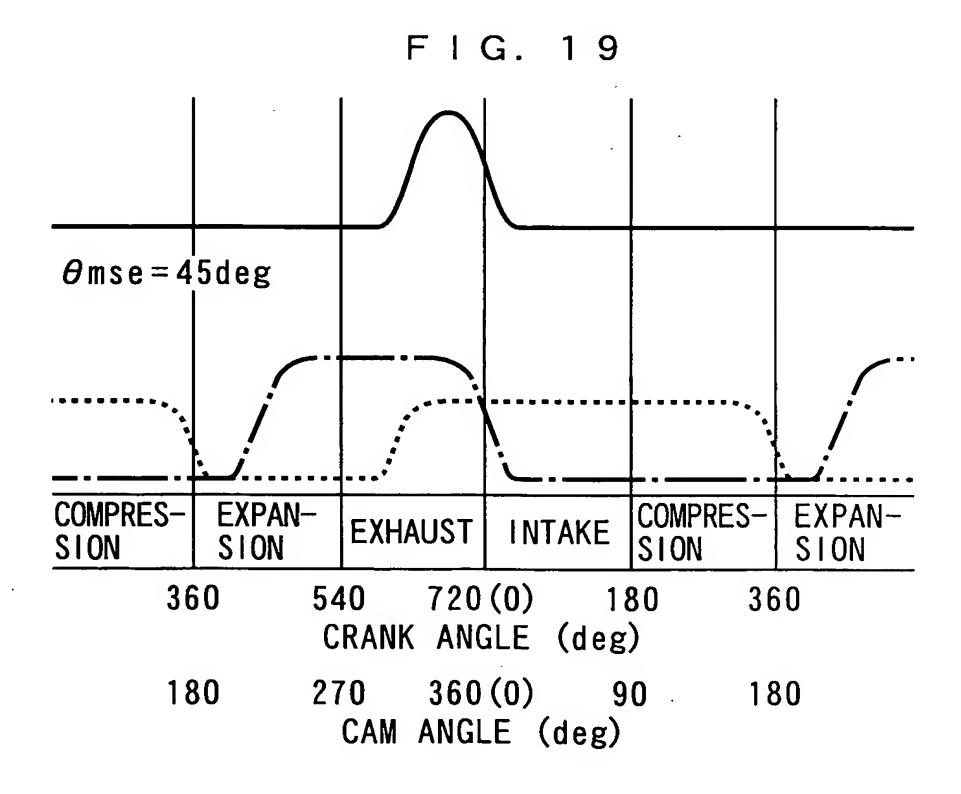
H 0 3 - 1 2 6 8

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(18/54)

F | G. 18



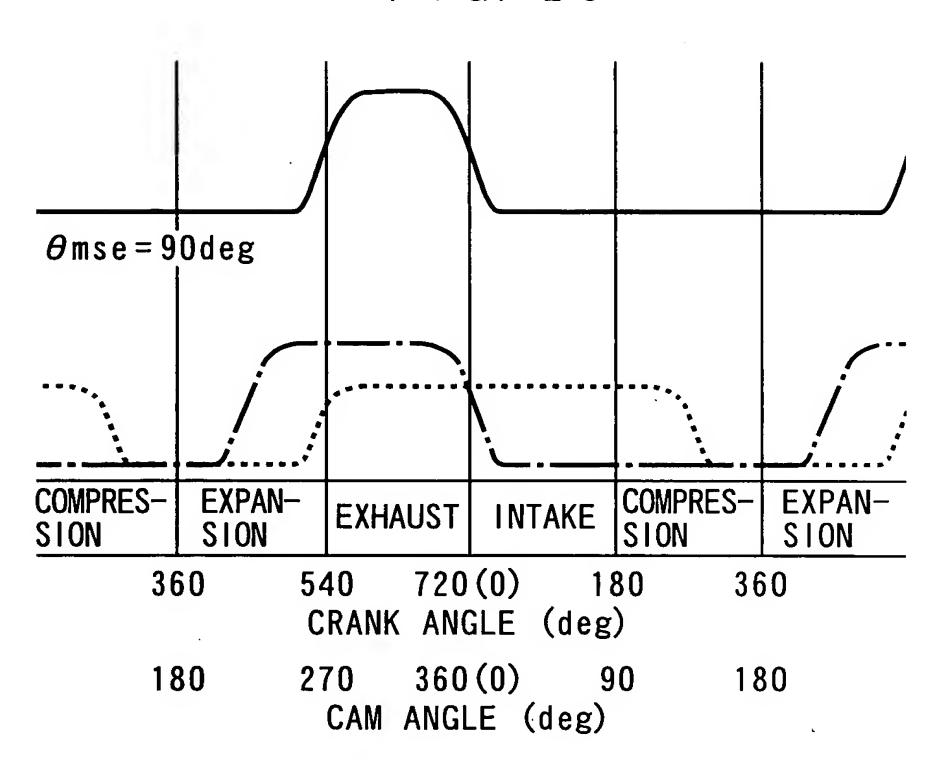


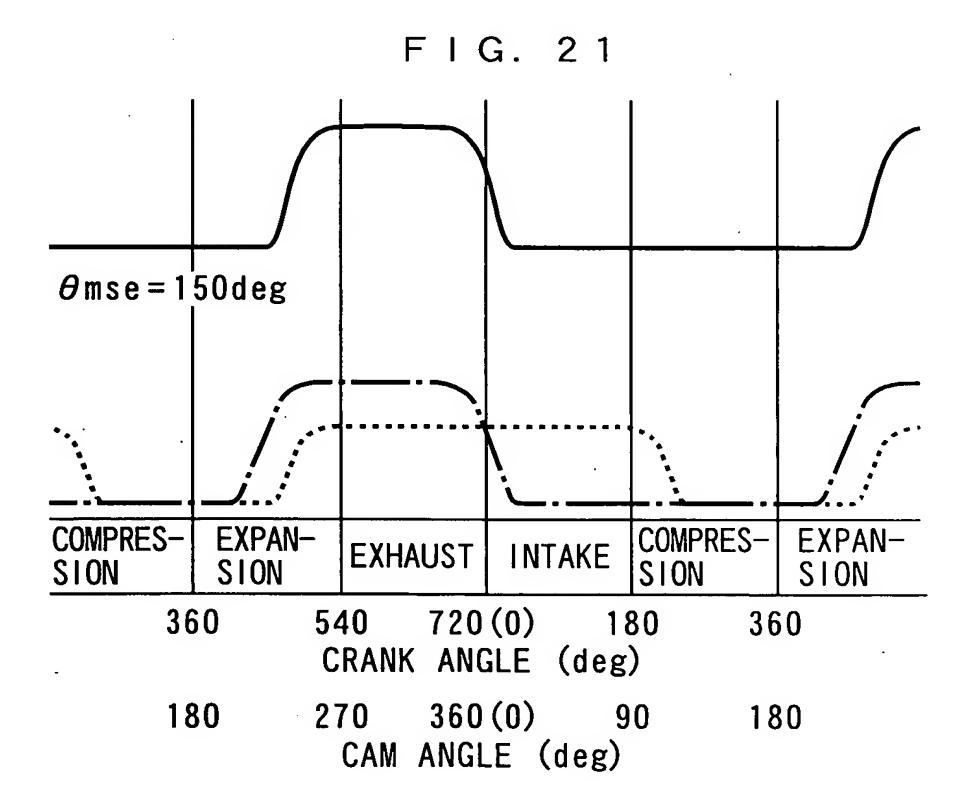
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Inventor: YASUI, et al.
Appln. No.: New Application
Docket No.: 108419-00076

(19/54)





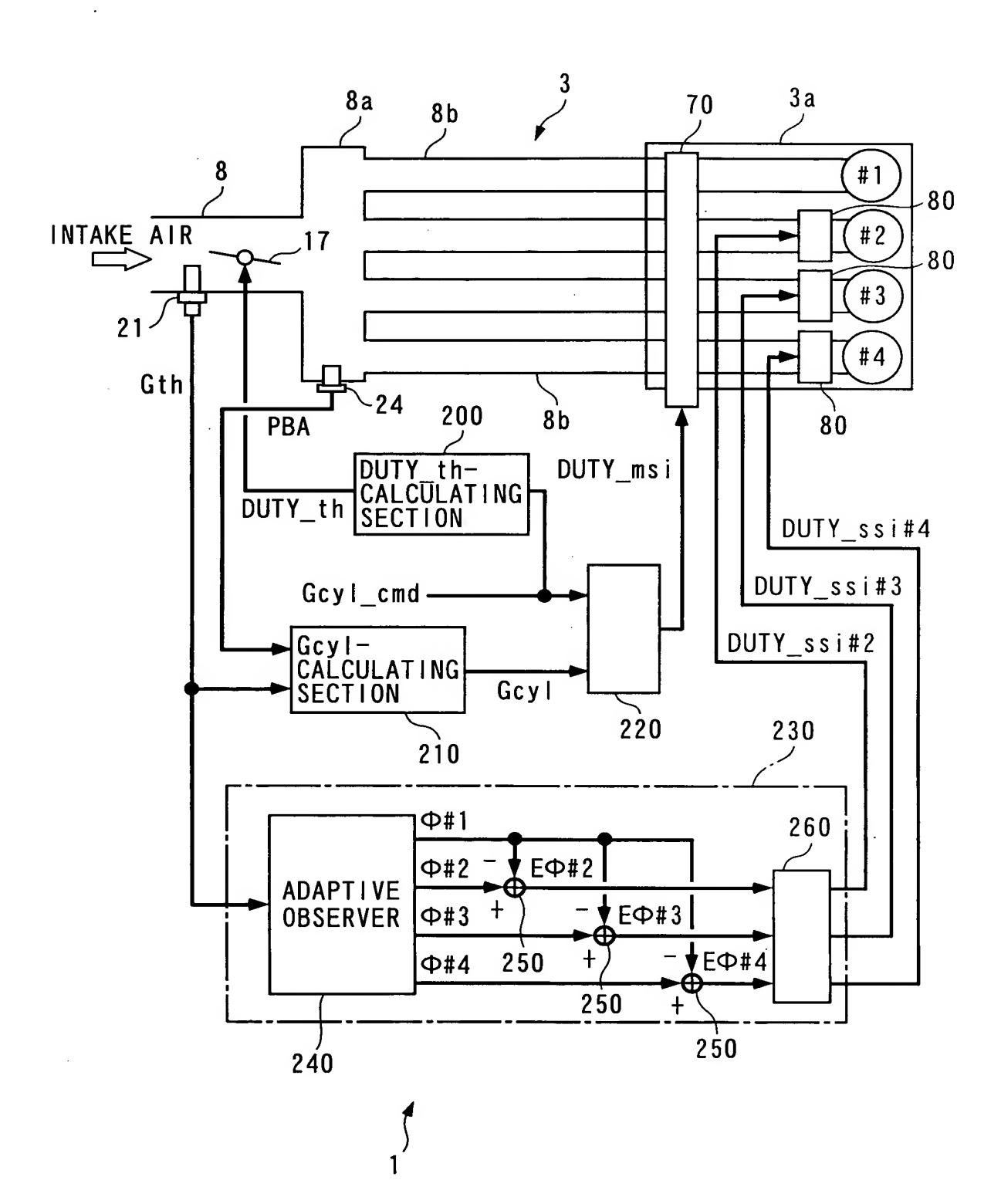


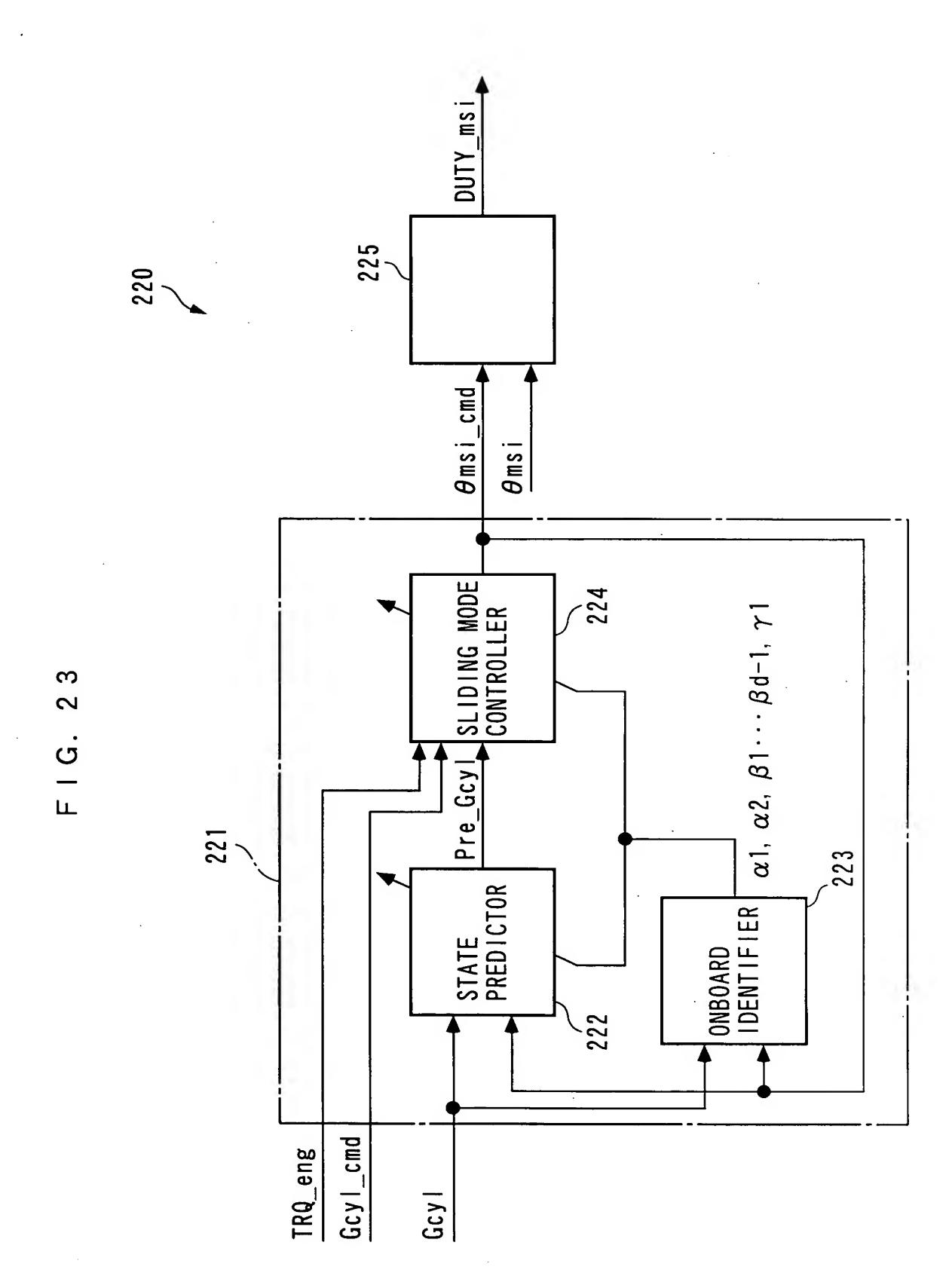
H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(20/54)

F I G. 22





H03-1268

Internal 1Comnbustion Engine and Control

System

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(22/54)

FIG. 24

Gcyl(n)=Gth(n) -
$$\frac{VB \cdot [PBA(n)-PBA(n-1)]}{R \cdot TB} \qquad \cdots \qquad (1)$$

Gcyl(n)=
$$a1 \cdot Gcyl(n-1)+a2 \cdot Gcyl(n-2)+b1 \cdot \theta msi(n-d)$$
..... (2)

Gcyl(
$$n+d-1$$
) = $a1 \cdot Gcyl(n+d-2) + a2 \cdot Gcyl(n+d-3) + b1 \cdot \theta msi(n-1)$
 $\cdots \cdots (3)$

$$\mathbf{A} = \begin{bmatrix} \mathbf{a} & \mathbf{a} & \mathbf{a} & \mathbf{a} \\ \mathbf{1} & \mathbf{0} \end{bmatrix} \qquad \cdots \qquad (4)$$

$$\boldsymbol{B} = \begin{bmatrix} b1\\0 \end{bmatrix} \qquad \cdots \qquad (5)$$

Gcyl(n+d-1) =
$$\alpha$$
1·Gcyl(n) + α 2·Gcyl(n-1)
+ β 1· θ msi(n-1) + β 2· θ msi(n-2)
+···+ β d-1· θ msi(n-d+1) ····· (6)

 α 1: FIRST-ROW FIRST-COLUMN ELEMENT OF A^{d-1} α 2: FIRST-ROW SECOND-COLUMN ELEMENT OF A^{d-1} β j: FIRST-ROW ELEMENT OF A^{j-1} B (j=0 \sim d-1)

Pre_Gcyl(n) =
$$\alpha 1 \cdot Gcyl(n) + \alpha 2 \cdot Gcyl(n-1)$$

 $+\beta 1 \cdot \theta msi(n-1) + \beta 2 \cdot \theta msi(n-2)$
 $+\cdots + \beta d-1 \cdot \theta msi(n-d+1) + \gamma 1$
 $\Rightarrow Gcyl(n+d-1)$ (7)

Internal | Comnbustion Engine and Control

System

H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(23/54)

F I G. 25

$$\theta s(n) = \theta s(n-1) + KPs(n) \cdot ide(n)$$
 (8)

$$KPs(n) = \frac{Ps(n) \cdot \zeta s(n)}{1 + \zeta s(n)^{T} \cdot Ps(n) \cdot \zeta s(n)}$$
 (9)

$$Ps(n+1) = \frac{1}{\lambda 1} \left[I - \frac{\lambda 2 \cdot Ps(n) \cdot \zeta s(n) \cdot \zeta s(n)^{T}}{\lambda 1 + \lambda 2 \cdot \zeta s(n)^{T} \cdot Ps(n) \cdot \zeta s(n)} \right] Ps(n)$$
..... (10)

I: UNIT MATRIX OF ORDER d+2 λ1, λ2: WEIGHTING PARAMETER

$$\theta s(n)^T = [\alpha 1, \alpha 2, \beta 1, \beta 2, \cdots \beta d-1, \gamma 1] \cdots (1 2)$$

$$\zeta s(n)^T = [Gcyl(n-d), Gcyl(n-d-1),$$

$$\theta msi(n-d), \theta msi(n-d-1), \cdots, \theta msi(n-2d+2), 1]$$

$$\cdots \cdots (1 3)$$

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Internal | Commbustion Engine and Control

System

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(24/54)

FIG. 26

Gcyl(n+d) =
$$\alpha$$
1·Gcyl(n+1) + α 2·Gcyl(n)
+ β 1· θ msi(n) + β 2· θ msi(n-1)
+···+ β d-1· θ msi(n-d+2)+ γ 1 ····· (1 4)

Es (n) = Gcyl (n) - Gcyl_cmd (n)
$$\cdots (15)$$

$$\sigma s(n) = Es(n) + Ss \cdot Es(n-1)$$
 (1 6)

$$-1 < Ss < 0$$
 $\cdots (17)$

$$\theta$$
msi_cmd(n)=Uspas(n)
=Ueq(n)+Urch(n)+Uvt(n) $\cdots (18)$

Ueq(n) =
$$\frac{1}{\beta 1}$$
 {Pre_Gcyl(n)+Ss·Pre_Gcyl(n-1)
 $-\alpha 1 \cdot \text{Pre_Gcyl(n-d+1)} - \alpha 2 \cdot \text{Gcyl(n)}$
 $-\beta 2 \cdot \theta \text{msi(n-1)} - \cdots - \beta d-1 \cdot \theta \text{msi(n-d+2)} - \gamma 1$
 $+\text{Gcyl_cmd(n+d)} + (\text{Ss-1}) \cdot \text{Gcyl_cmd(n+d-1)}$
 $-\text{Ss·Gcyl_cmd(n+d-2)}$ (19)

$$Urch(n) = \frac{-F}{B1} \cdot \sigma s (n+d-1) \qquad \cdots \qquad (2 0)$$

F: REACHING LAW GAIN (0 < F < 2)

Uvt(n) =
$$\theta$$
msi_base(n) (2 1)

/ILLE. Intake-Air-Amount Control-System-For-Internal lComnbustion Engine and Control

System

H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(25/54)

$$\sigma s(n+d) = \sigma s(n+d-1) \qquad \cdots \qquad (2 2)$$

Es
$$(n+d)+Ss\cdot Es(n+d-1)=Es(n+d-1)+Ss\cdot Es(n+d-2)$$
 (2 3)

$$\alpha 1 \cdot Gcyl(n+1) + \alpha 2 \cdot Gcyl(n) + \beta 1 \cdot \theta msi(n) + \beta 2 \cdot \theta msi(n-1)$$

$$+ \cdots + \beta d - 1 \cdot \theta msi(n-d+2) + \gamma 1 - Gcyl_cmd(n+d)$$

$$+ Ss \cdot Gcyl(n+d-1) - Ss \cdot Gcyl_cmd(n+d-1)$$

$$= Gcyl(n+d-1) - Gcyl_cmd(n+d-1)$$

$$+ Ss \cdot Gcyl(n+d-2) - Ss \cdot Gcyl_cmd(n+d-2)$$

$$\cdots \cdots (2 4)$$

$$\theta msi(n) = \frac{1}{\beta 1} \{Gcyl(n+d-1) + Ss \cdot Gcyl(n+d-2) \\ -\alpha 1 \cdot Gcyl(n+1) - \alpha 2 \cdot Gcyl(n) \\ -\beta 2 \cdot \theta msi(n-1) - \cdots -\beta d-1 \cdot \theta msi(n-d+2) - \gamma 1 \\ +Gcyl_cmd(n+d) + (Ss-1) \cdot Gcyl_cmd(n+d-1) \\ -Ss \cdot Gcyl_cmd(n+d-2)\} \qquad \cdots \qquad (25)$$

Title. Tillake Air Amount Control System For Internal lComnbustion Engine and Control System

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(26/54)

F I G. 28

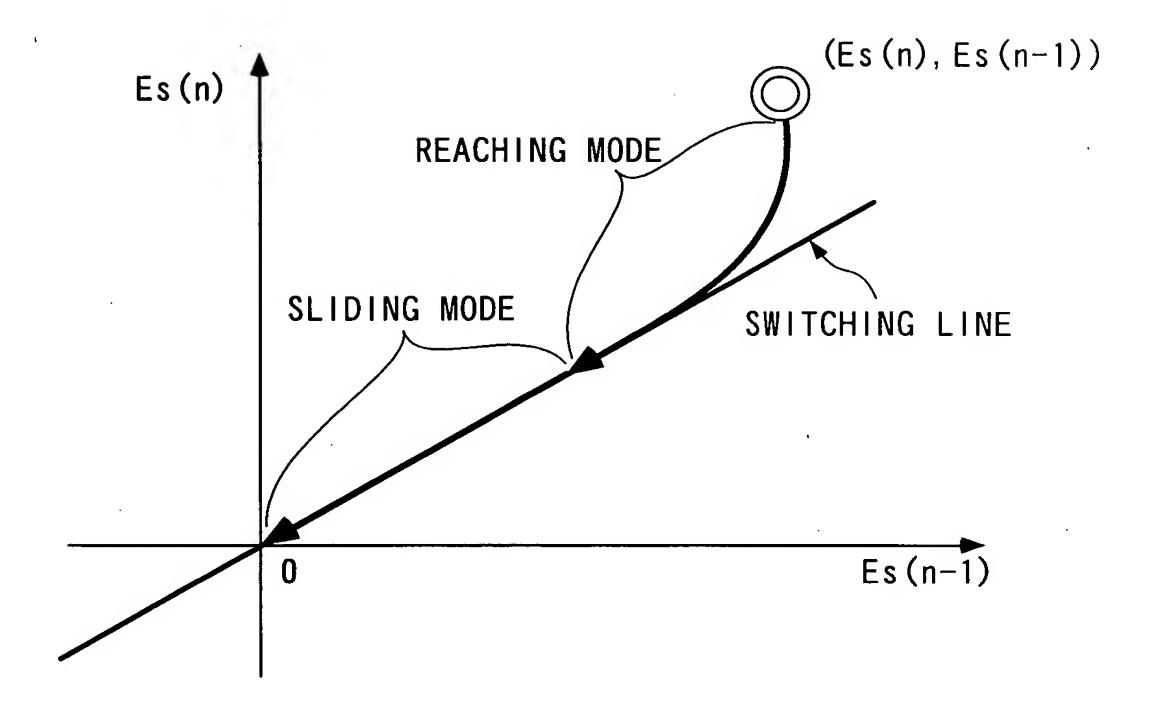
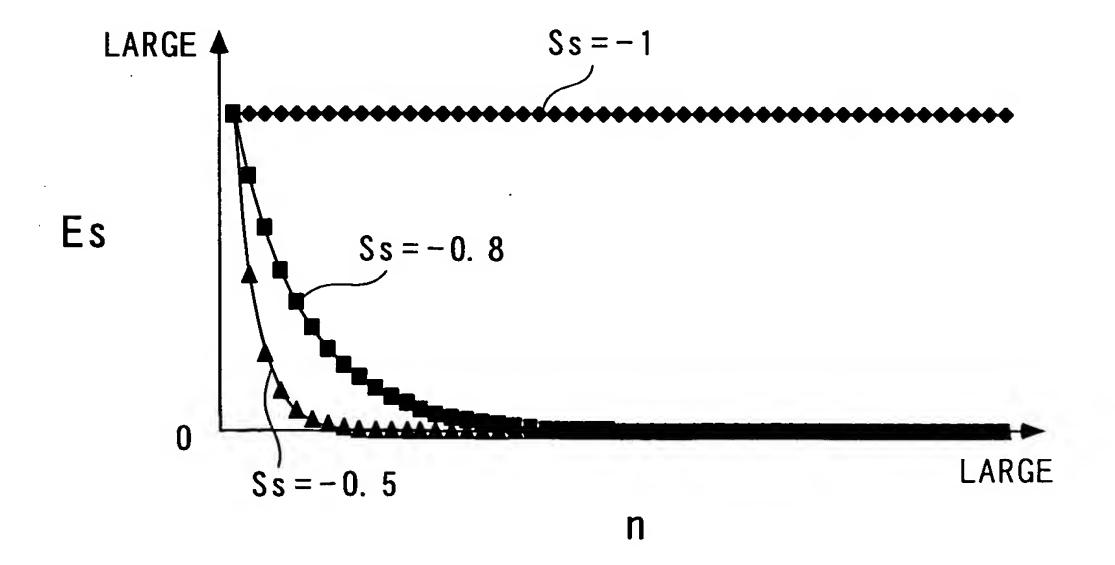


FIG. 29



Internal 1Comnbustion Engine and Control.

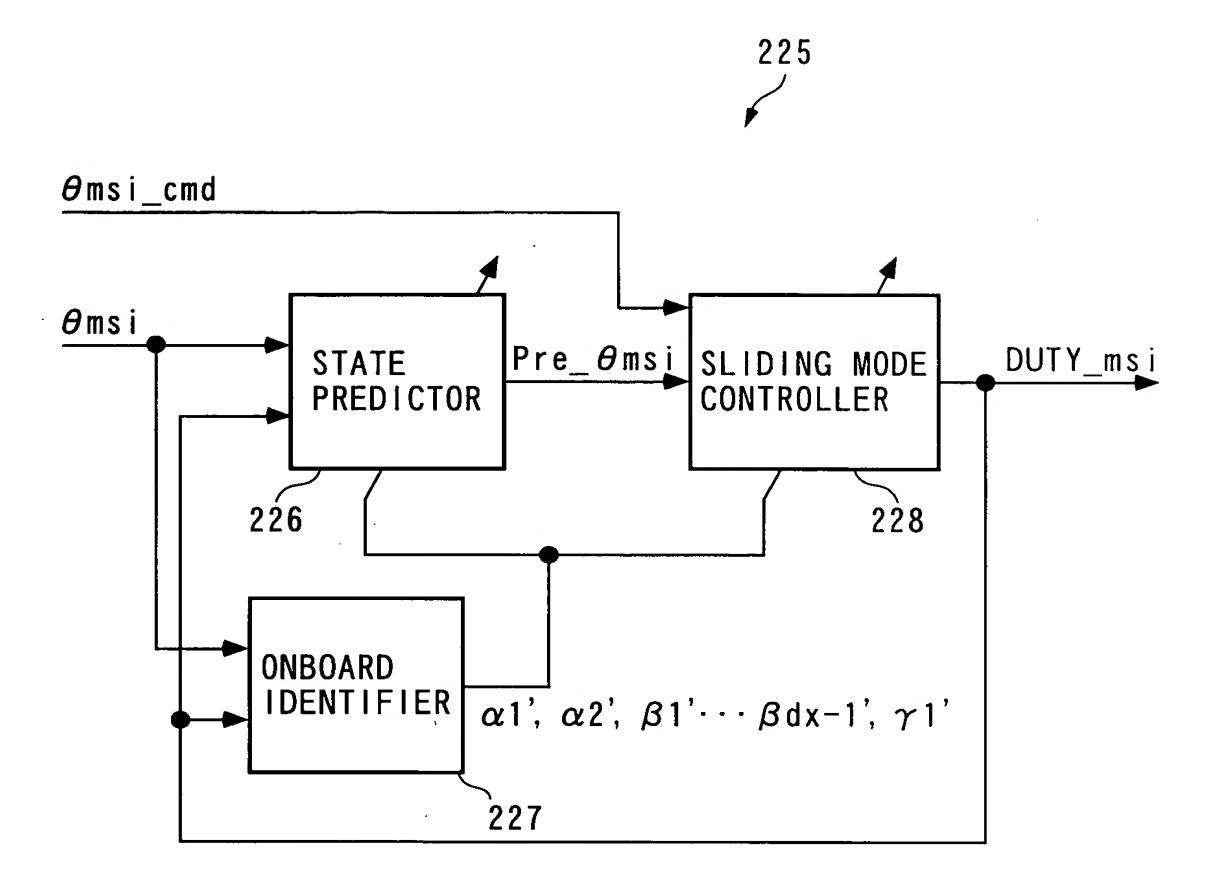
System
Inventor: YAS

H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(27/54)

F I G. 30



Internal IComnbustion Engine and Control

System

H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(28/54)

FIG. 31

$$\theta$$
msi(m) = a1'· θ msi(m-1)+a2'· θ msi(m-2)+b1'·DUTY_msi(m-dx)

 \cdots (26)

$$\mathbf{A}' = \begin{bmatrix} \mathbf{a}\mathbf{1}' & \mathbf{a}\mathbf{2}' \\ \mathbf{1} & \mathbf{0} \end{bmatrix} \qquad \cdots \qquad (2 7)$$

$$\boldsymbol{B'} = \begin{bmatrix} b1' \\ 0 \end{bmatrix} \qquad \cdots \qquad (28)$$

Pre_
$$\theta$$
msi (m) = $\alpha 1' \cdot \theta$ msi (m) + $\alpha 2' \cdot \theta$ msi (m-1)
+ $\beta 1' \cdot DUTY_m$ si (m-1) + $\beta 2' \cdot DUTY_m$ si (m-2)
+ $\cdots + \beta dx - 1' \cdot DUTY_m$ si (m-dx+1) + $\gamma 1'$
 $\Rightarrow \theta$ msi (m+dx-1) $\cdots (29)$

 α 1': FIRST-ROW FIRST-COLUMN ELEMENT OF A'^{dx-1} α 2': FIRST-ROW SECOND-COLUMN ELEMENT OF A'^{dx-1} β j': FIRST-ROW ELEMENT OF A'^{j-1} B' (j'=0 \sim dx-1)

Internal IComnbustion Engine and Control

System

H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(29/54)

F I G. 32

$$\theta$$
 s'(m) = θ s'(m-1) + KPs'(m) · ide'(m) ····· (3 0)

$$KPs'(m) = \frac{Ps'(m) \cdot \zeta s'(m)}{1 + \zeta s'(m)^{T} \cdot Ps'(m) \cdot \zeta s'(m)} \cdot \cdot \cdot \cdot (31)$$

$$Ps'(m+1) = \frac{1}{\lambda 1'} \left[I' - \frac{\lambda 2' \cdot Ps'(m) \cdot \zeta s'(m) \cdot \zeta s'(m)^{T}}{\lambda 1' + \lambda 2' \cdot \zeta s'(m)^{T} \cdot Ps'(m) \cdot \zeta s'(m)} \right] Ps'(m)$$

$$\cdots (3 2)$$

I': UNIT MATRIX OF ORDER dx+2 λ 1', λ 2': WEIGHTING PARAMETER

ide'(m) = Pre_
$$\theta$$
 msi (m-dx+1) - θ msi (m)
= θ s'(m-1)^T · ζ s'(m) - θ msi (m) ····· (3 3)

$$\theta s'(m)^T = [\alpha 1', \alpha 2', \beta 1', \beta 2', \cdots \beta dx - 1', \gamma 1'] \cdots (3 4)$$

$$\zeta s'(m)^T = [\theta msi(m-dx), \theta msi(m-dx-1), \\DUTY_msi(m-dx), DUTY_msi(m-dx-1), \\\cdots, DUTY_msi(m-2dx+2), 1]$$
 \cdots (35)

Internal | Commbustion Engine and Control

System

H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(30/54)

F I G 3 3

Es'(m) =
$$\theta$$
 msi(m) - θ msi_cmd(m) (3.6)

$$\sigma s'(m) = Es'(m) + Ss' \cdot Es'(m-1) \qquad (3.7)$$

$$-1 < Ss' < 0$$
 (38)

DUTY_msi(m) = Uspas'(m) = Ueq'(m) + Urch'(m)
$$\cdots (39)$$

Ueq'(m) =
$$\frac{1}{\beta 1}$$
' {Pre_ θ msi(m) + Ss'·Pre_ θ msi(m-1)
 $-\alpha 1$ '·Pre_ θ msi(m-dx+1) - $\alpha 2$ '· θ msi(m)
 $-\beta 2$ '·DUTY_msi(m-1) - ···- β dx-1'·DUTY_msi(m-dx+2) - $\gamma 1$ '
 $+\theta$ msi_cmd(m+dx) + (Ss'-1) · θ msi_cmd(m+dx-1)
 $-$ Ss'· θ msi_cmd(m+dx-2)} ····· (4 0)

Urch'(n) =
$$\frac{-F'}{\beta 1'}$$
 · σ s'(m+dx-1) (4 1)

F': REACHING LAW GAIN (0 < F' < 2)

H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(31/54)

FIG. 34

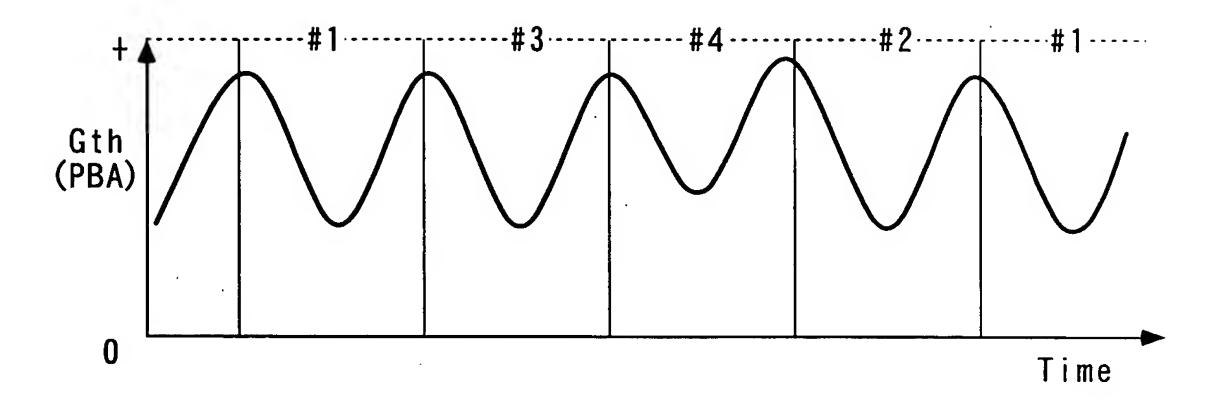
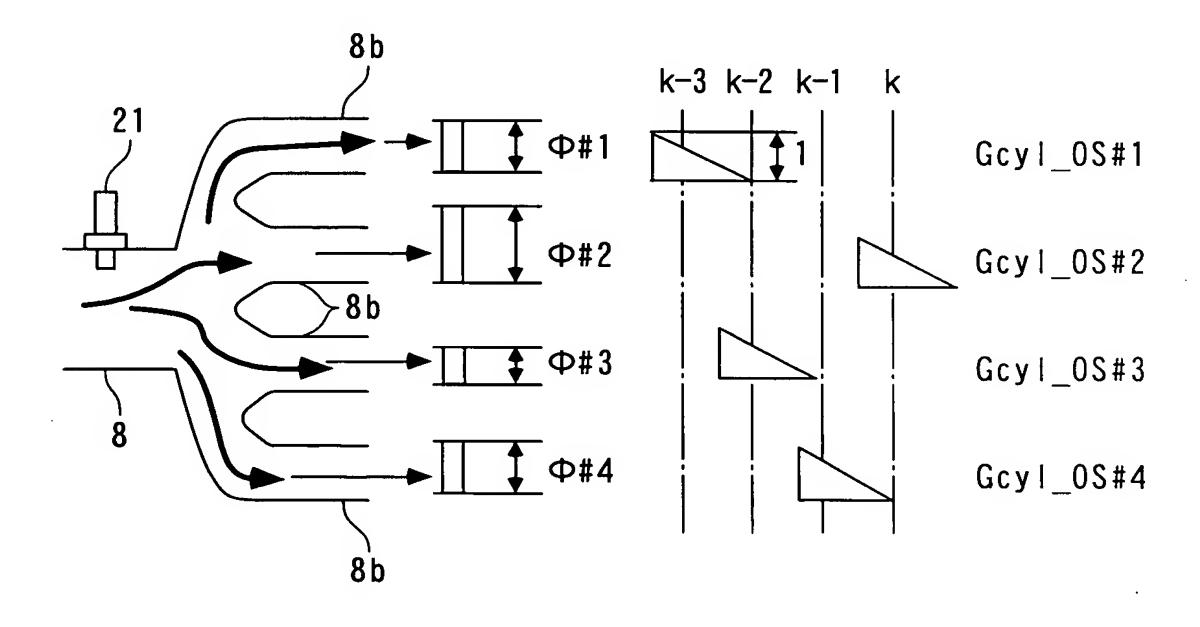


FIG. 35



—I IIIC. TIIIAKCAII Aaalolii ale o olaata ole aysee ee e Internal IComnbustion Engine and Control

System

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(32/54)

F I G. 36

 $\cdots (42)$

Gth_est(k) =
$$\Phi$$
#1(k) · Gcyl_0S#1(k) + Φ #2(k) · Gcyl_0S#2(k)
+ Φ #3(k) · Gcyl_0S#3(k) + Φ #4(k) · Gcyl_0S#4(k)

····· (4 3)

$$\phi(k) = \phi(k-1) + KR(k) \cdot ide'(k)$$

H03-1268

 $\cdots (44)$

$$KR(k) = \frac{R(k) \cdot \zeta'(k)}{1 + \zeta'(k)^{T} \cdot R(k) \cdot \zeta'(k)} \qquad \cdots \qquad (4 5)$$

 $ide'(k) = Gth(k-d') - Gth_est(k)$

 $\cdots (46)$

Gth_est(k) =
$$\phi(k-1)^T \zeta'(k)$$

.... (47)

$$R(k+1) = \frac{1}{\lambda 1''} \left[I - \frac{\lambda 2'' \cdot R(k) \cdot \zeta'(k) \cdot \zeta'(k)^{T}}{\lambda 1'' + \lambda 2'' \cdot \zeta'(k)^{T} \cdot R(k) \cdot \zeta'(k)} \right] R(k)$$

.... (48)

I: UNIT MATRIX λ1", λ2": WEIGHTING PARAMETER

$$\phi(k)^T = [\Phi#1(k), \Phi#2(k), \Phi#3(k), \Phi#4(k)]$$

· · · · · (49)

$$\zeta'(k)^{T} = [Gcyl_0S#1(k), Gcyl_0S#2(k), Gcyl_0S#3(k), Gcyl_0S#4(k)]$$

 \cdots (50)

Internal IComnbustion Engine and Control

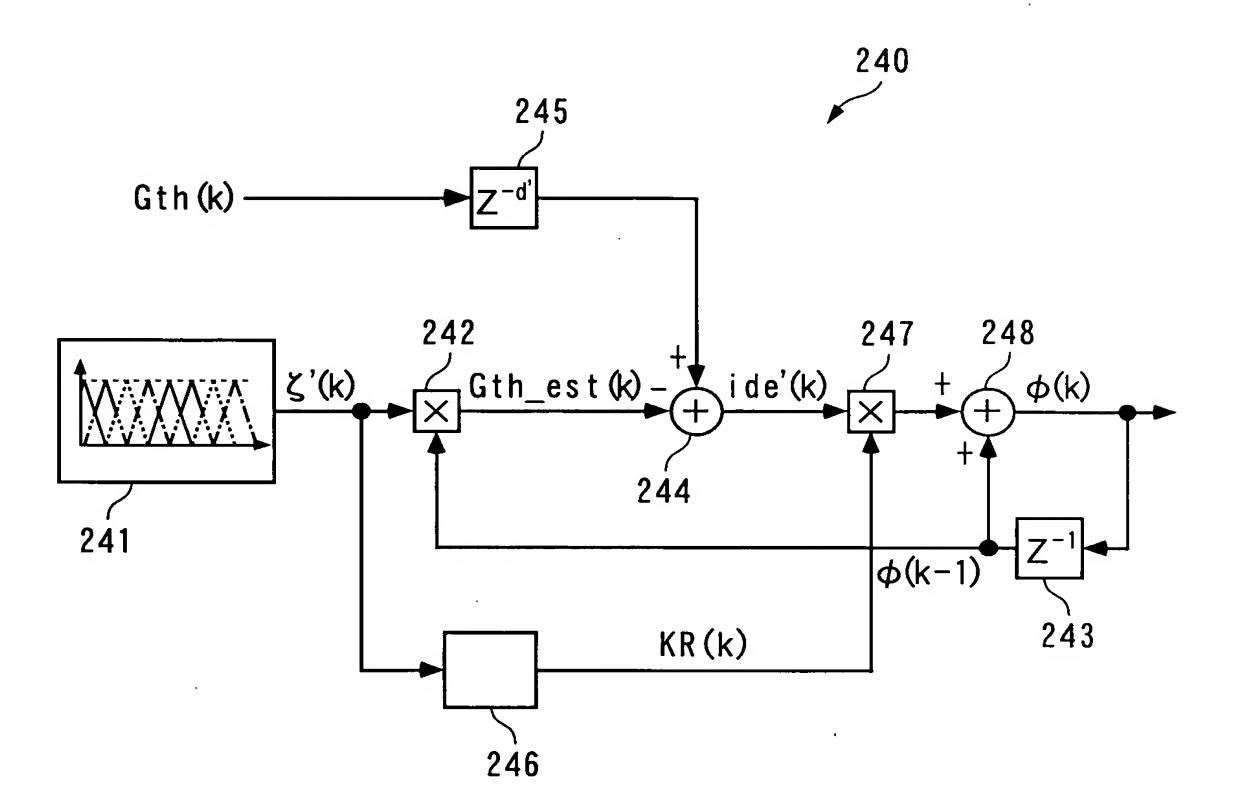
System

H 0 3 - 1 2 6 8

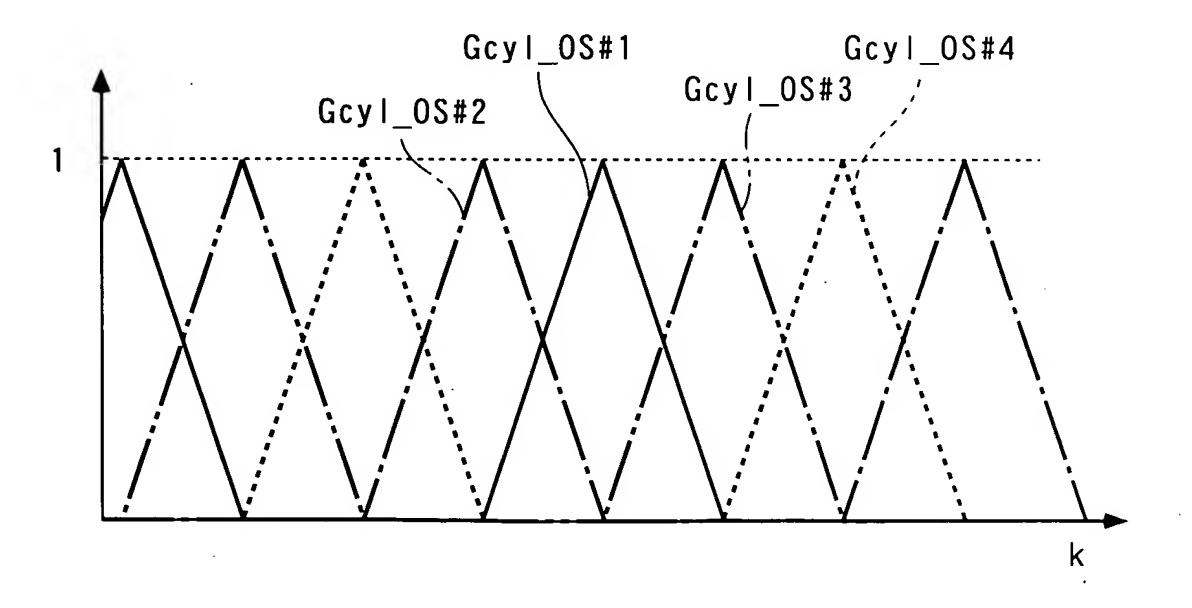
Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(33/54)

F I G. 37



F I G. 38



/ Title: Intake An Amount Control System ror Internal IComnbustion Engine and Control

System

H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(34/54)

EΦ#i(k)=Φ#i(k)-Φ#1(k) (5 1)
$$(i=2\sim4)$$

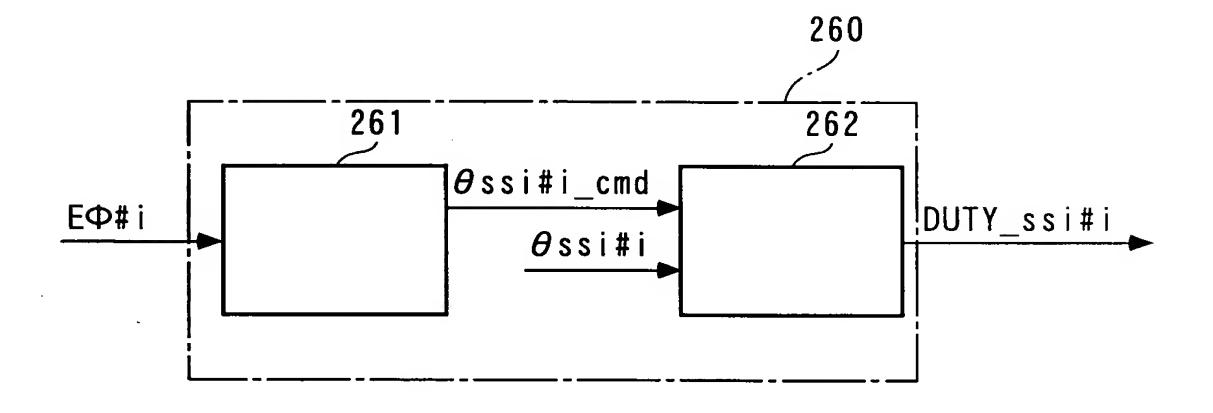
$$\sigma'(k) = E\Phi \# i(k) + S'E\Phi \# i(k-1)$$
 (5 2)

$$\theta ss # i _cmd(k) = -Fs' \cdot \sigma'(k) - Gs' \cdot \sum_{j=0}^{k} \sigma'(j) - Hs' \cdot E\Phi # i(k)$$

$$\cdots \qquad (5 3)$$

Fs', Gs', Hs': FEEDBACK GAIN S': SWITCHING FUNCTION-SETTING PARAMETER (-1 < S' < 1)

F I G. 40



Internal 1Comnbustion Engine and Control

System

H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(35/54)

F I G. 41

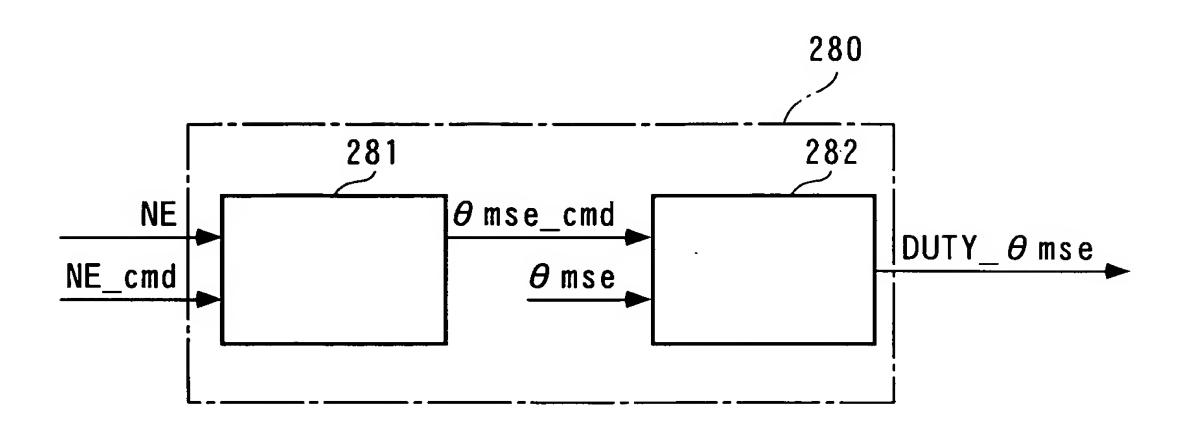


FIG. 42

$$\theta$$
mse_cmd(n) = θ mse_ast(n) + d θ mse(n) (5 4)

$$d\theta mse(n) = -Kastr \cdot \sigma ast(n) + \left[-Kasta \cdot \sum_{i=0}^{n} \sigma ast(i) \right]$$
..... (5 5)

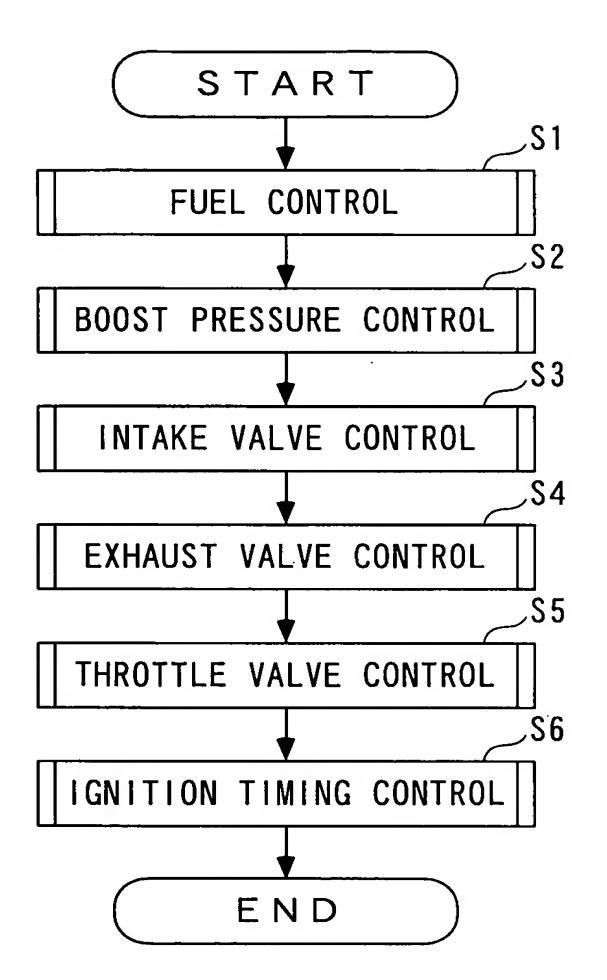
$$\sigma$$
ast(n)=NE(n)-NE_cmd(n)+Sast·[NE(n-1)-NE_cmd(n-1)] $\cdots \cdots (5 6)$

H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(36/54)

F | G. 43

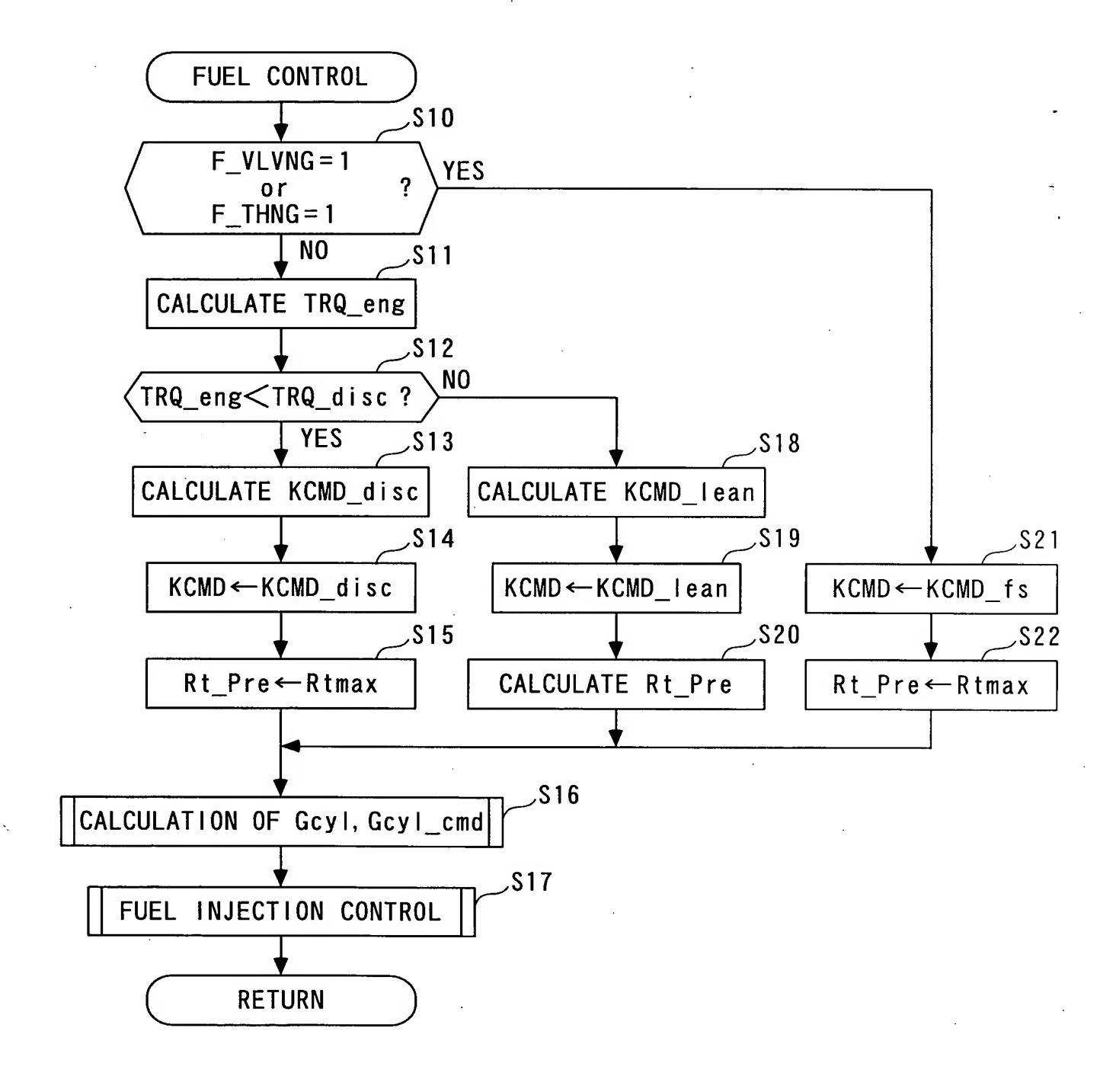


H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(37/54)

FIG. 44



H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

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(38/54)

F I G. 45

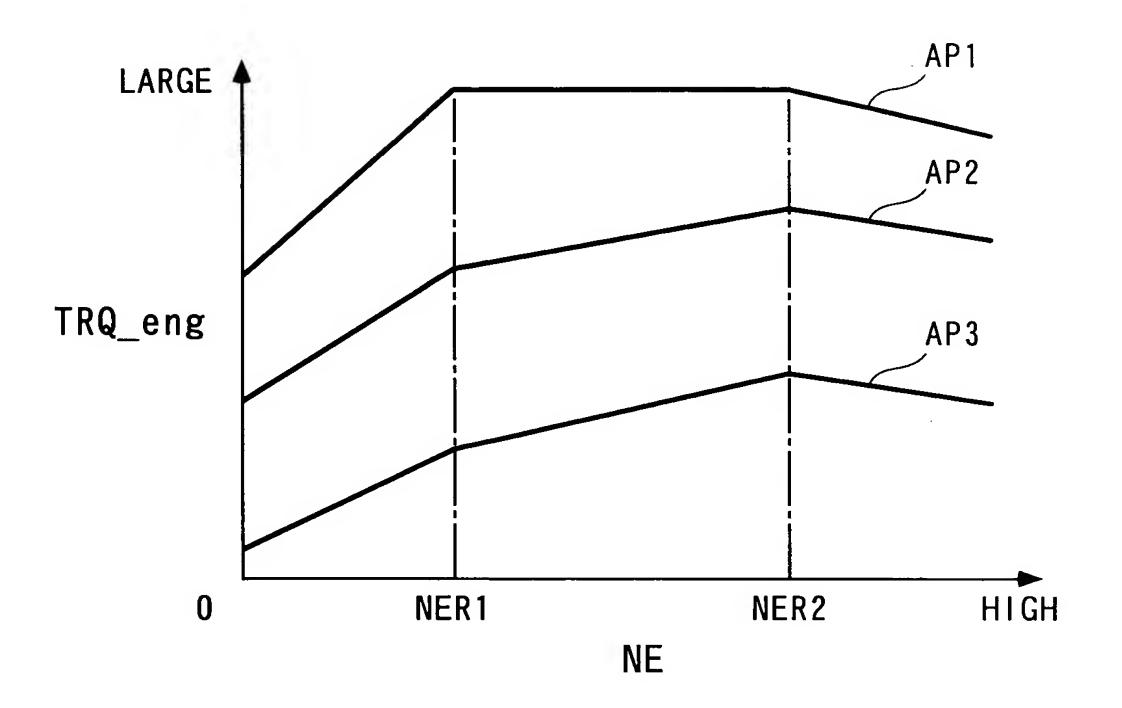
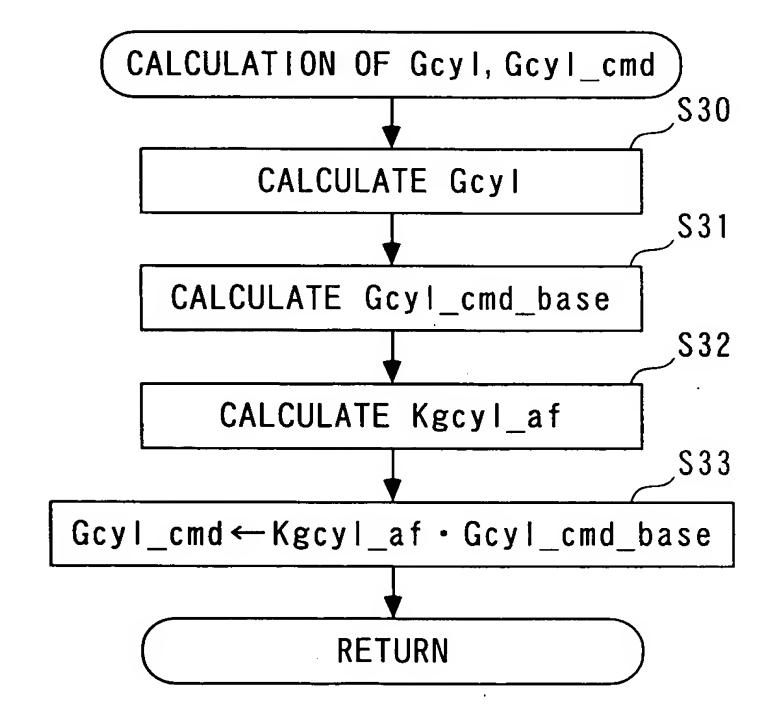


FIG. 46



H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(39/54)

FIG. 47

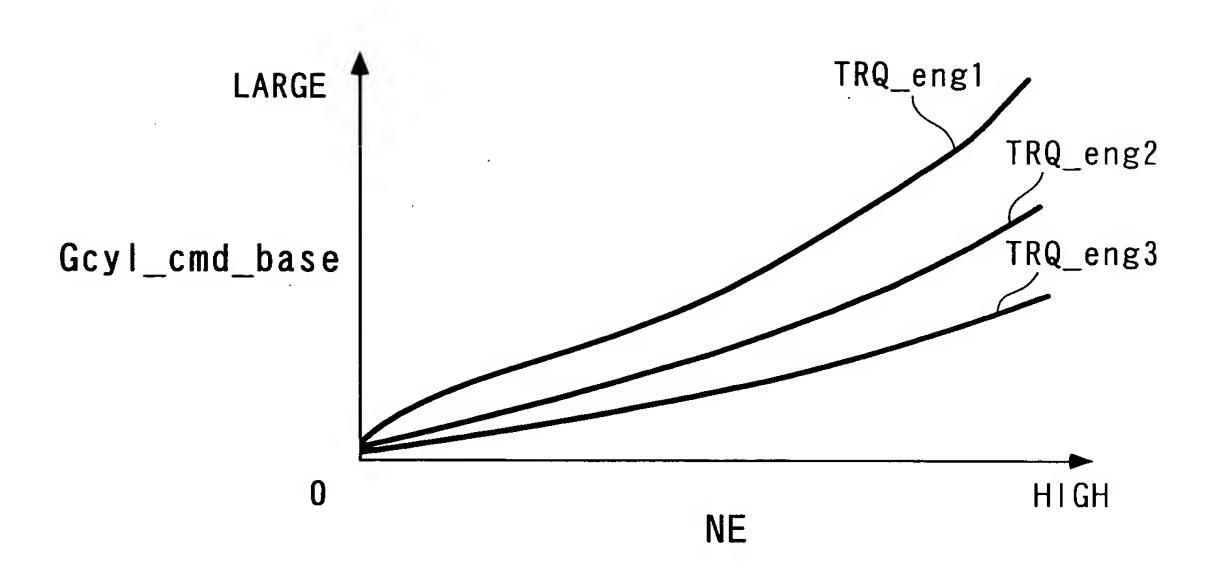
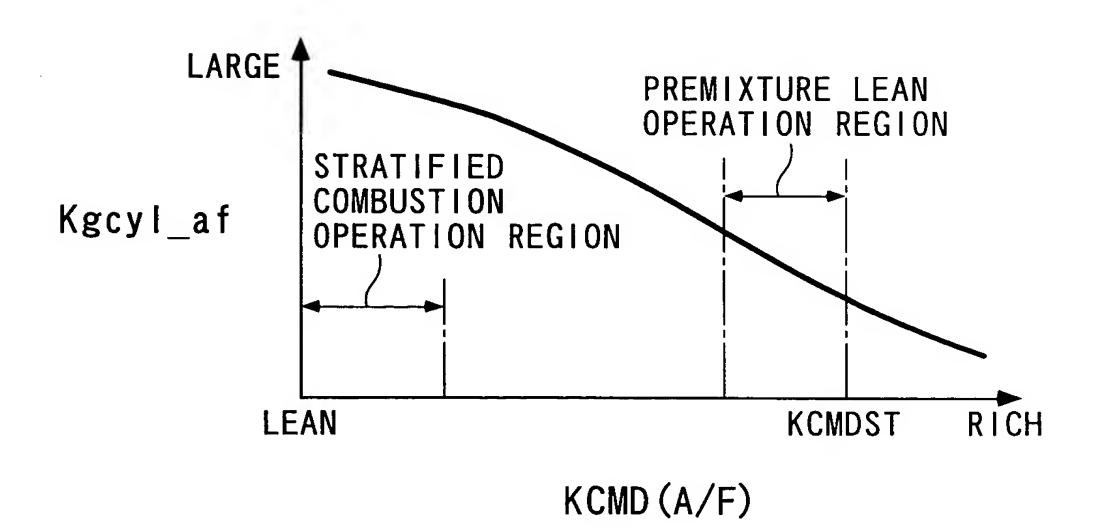


FIG. 48



Titte. Tintake Air Amount Control System For Internal lComnbustion Engine and Control

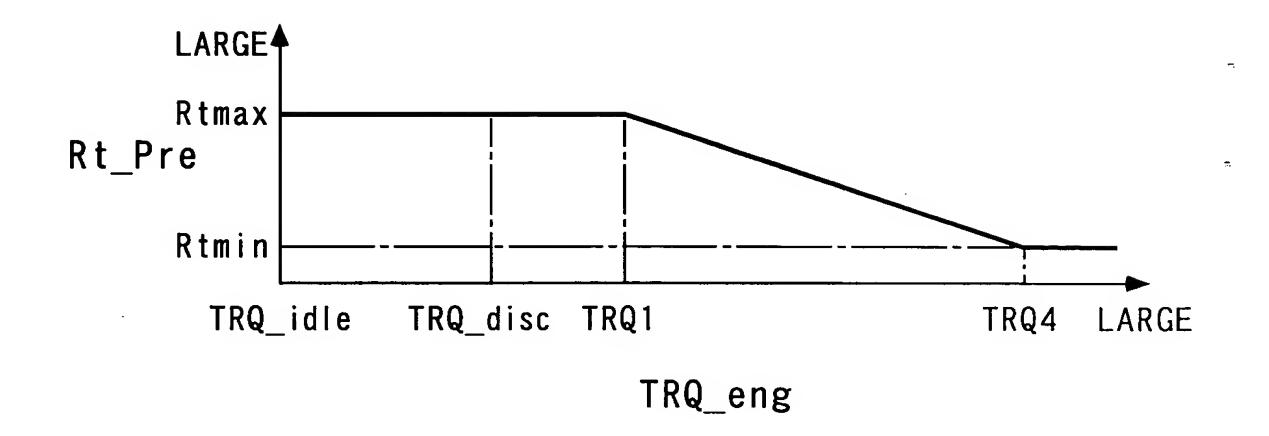
System

H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(40/54)

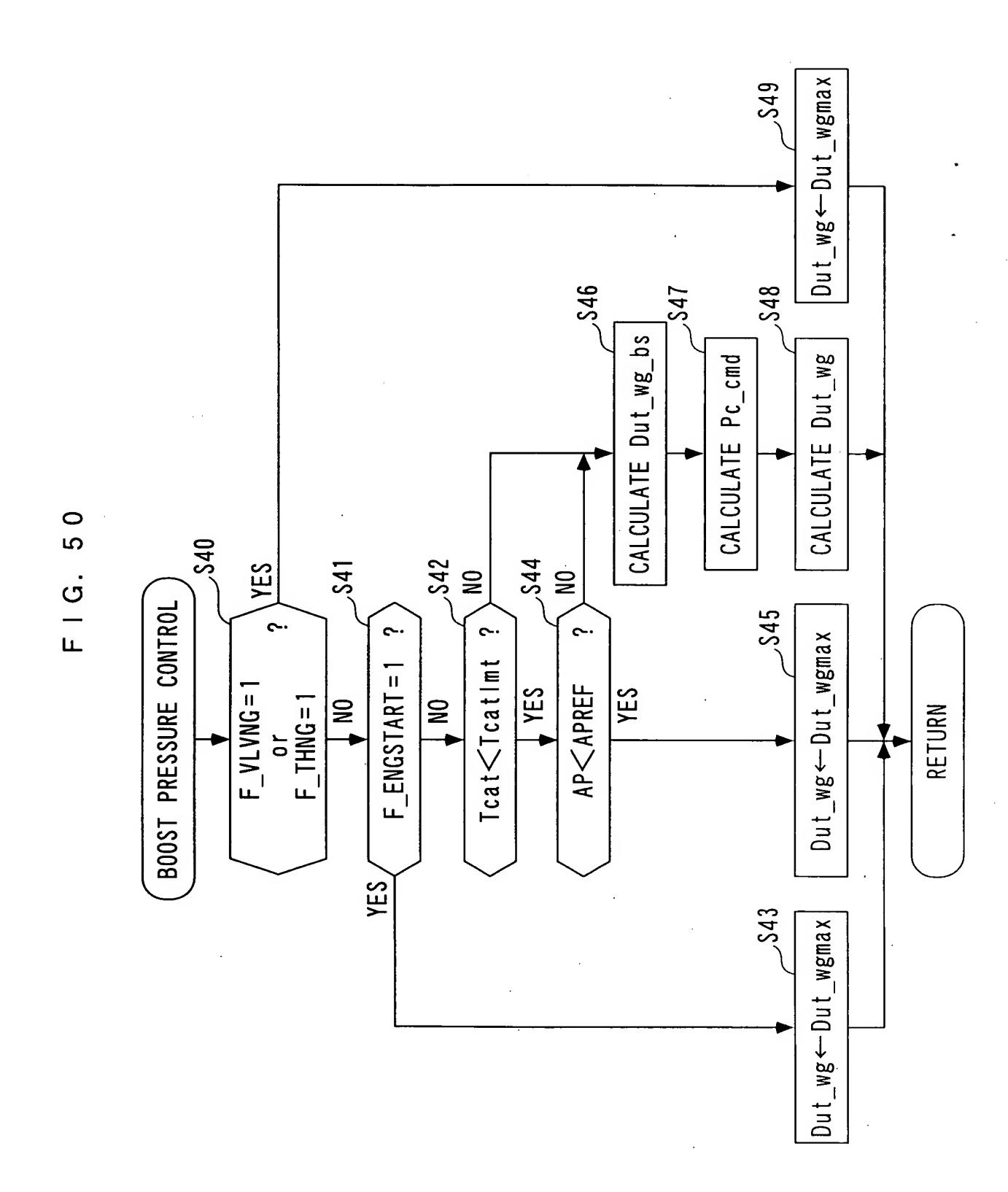
FIG. 49



H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(41/54)



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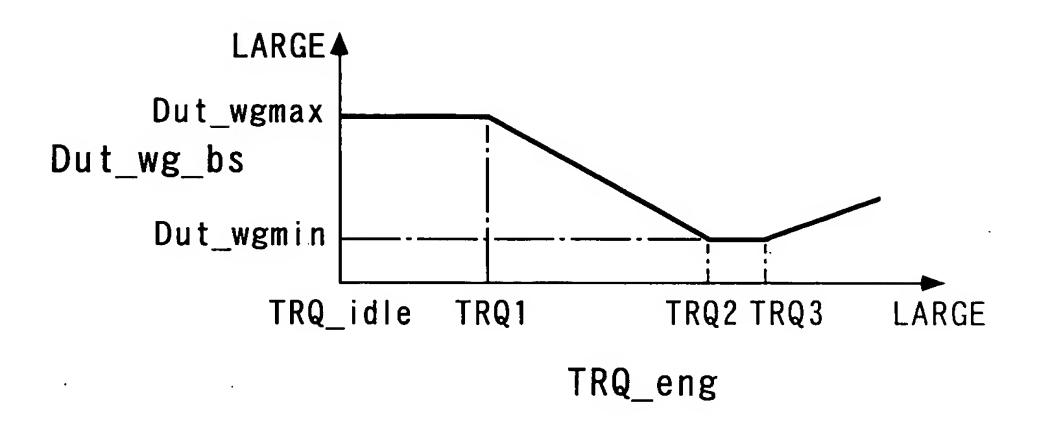
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H03-1268

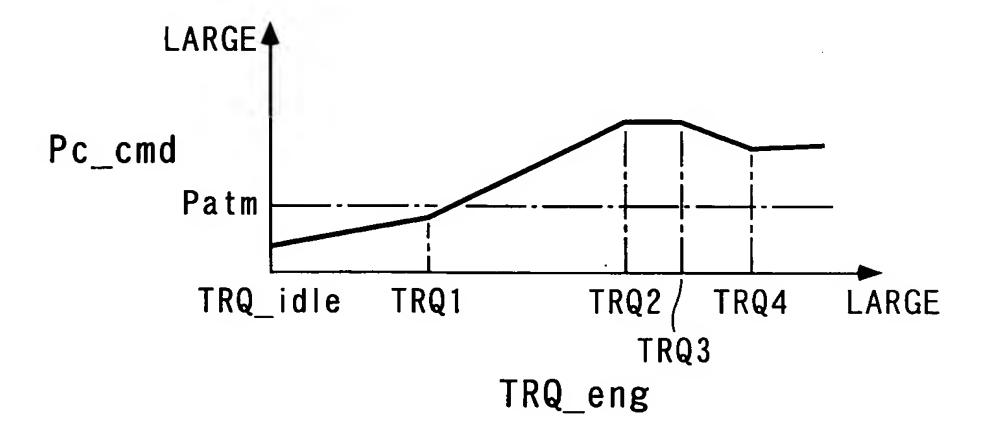
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(42/54)

FIG. 51

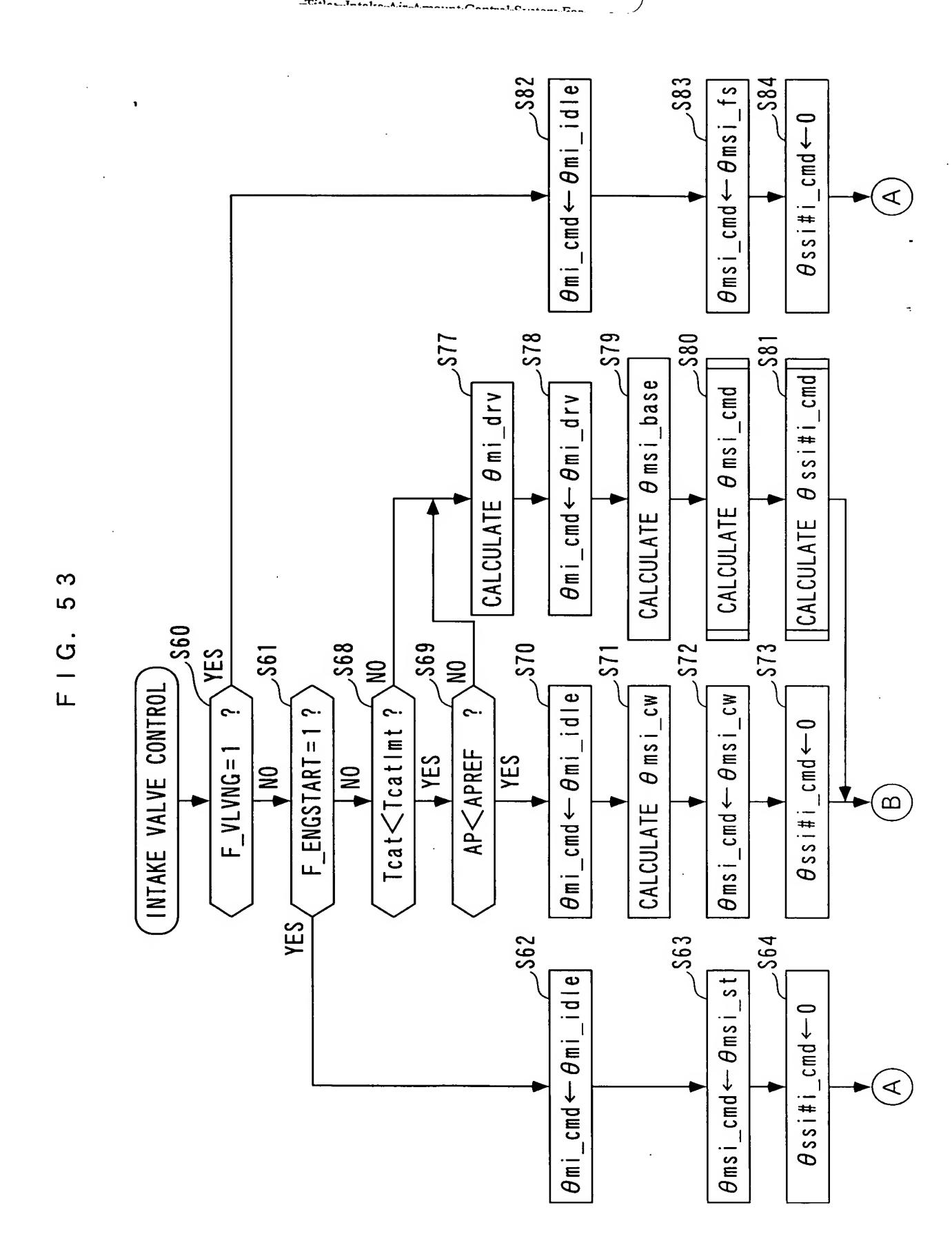


F I G. 52



Appln. No.: New Application Docket No.: 108419-00076

(43/54)

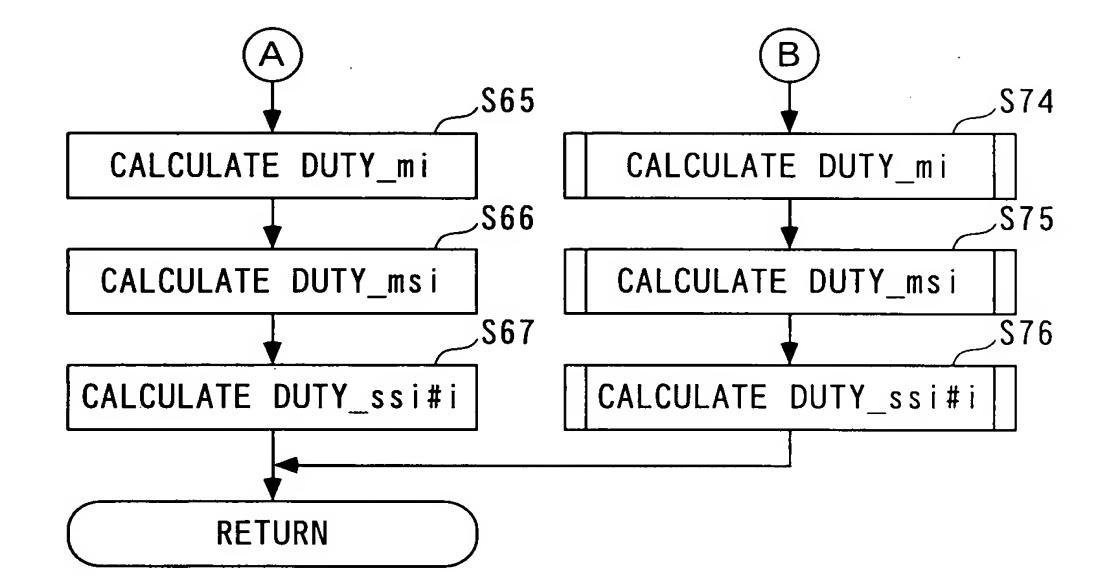


H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(44/54)

FIG. 54

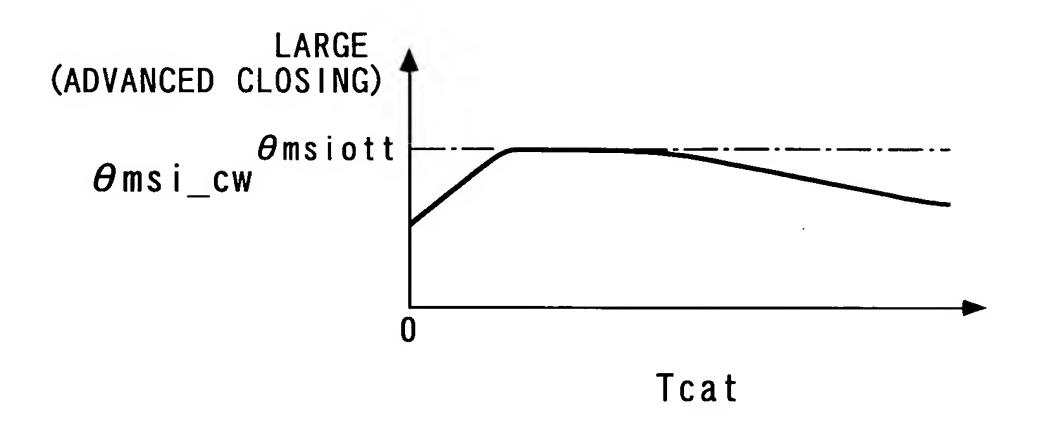


H 0 3 - 1 2 6 8

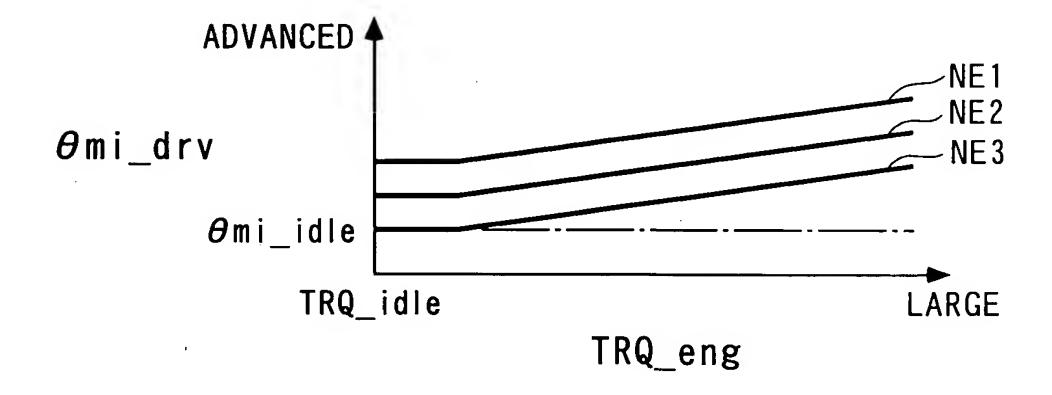
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(45/54)

FIG. 55



F I G. 56

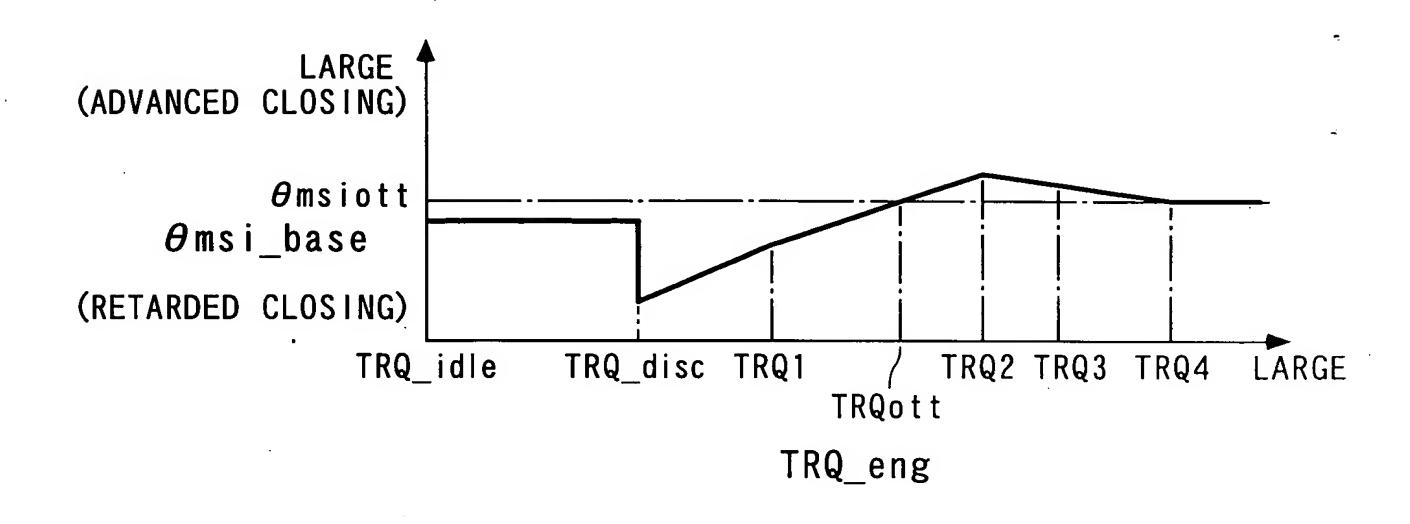


Internal IComnbustion Engine and Control
System

System
Inventor: YASUI, et al.
Appln. No.: New Application
Docket No.: 108419-00076

(46/54)

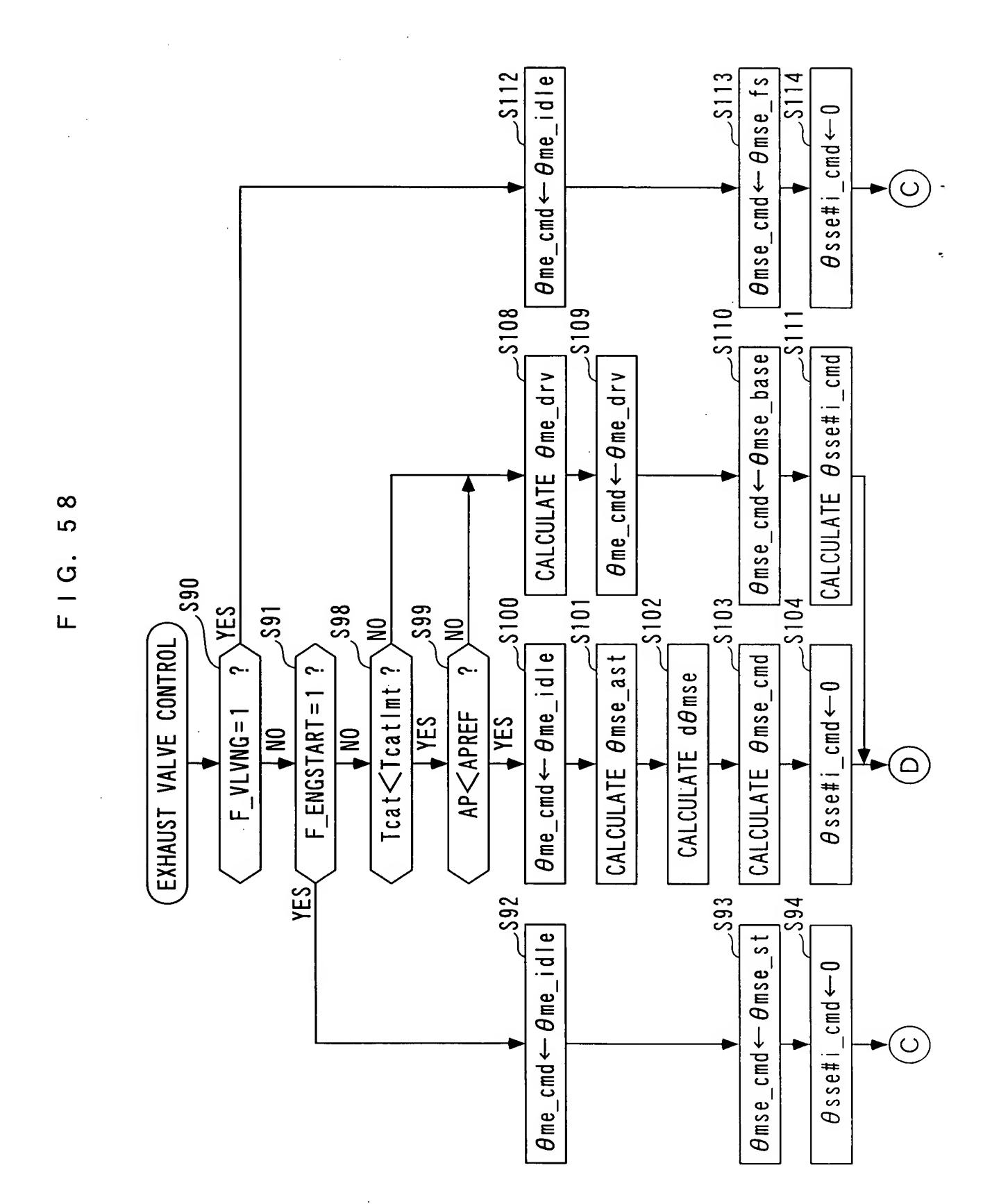
F | G. 57



H 0 3 - 1 2 6 8

Inventor: YASUI, et al.
Appln. No.: New Application
Docket No.: 108419-00076

(47/54)

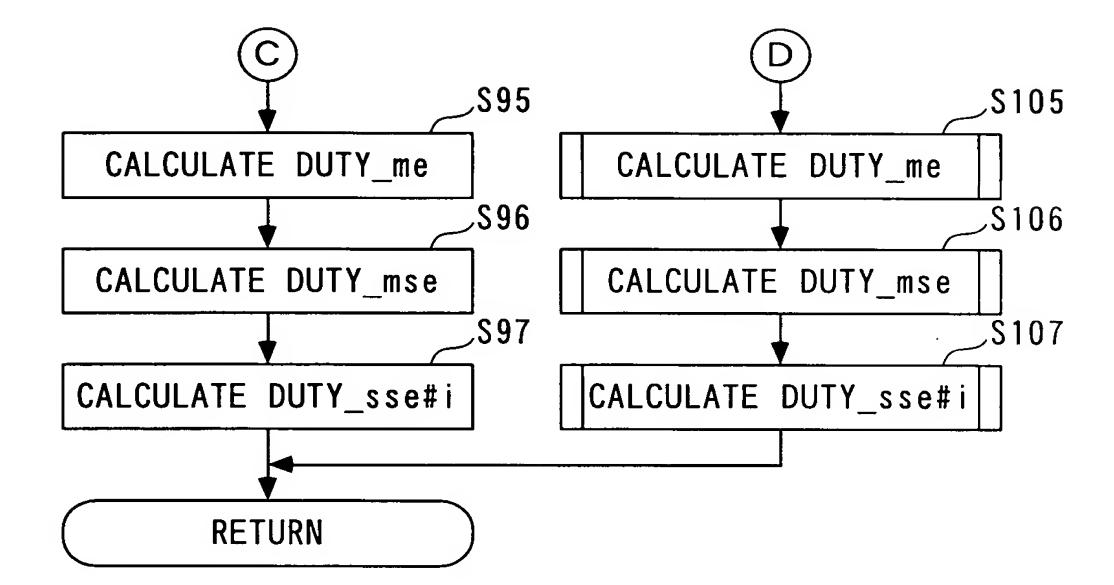


H 0 3 - 1 2 6 8

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(48/54)

F I G. 59



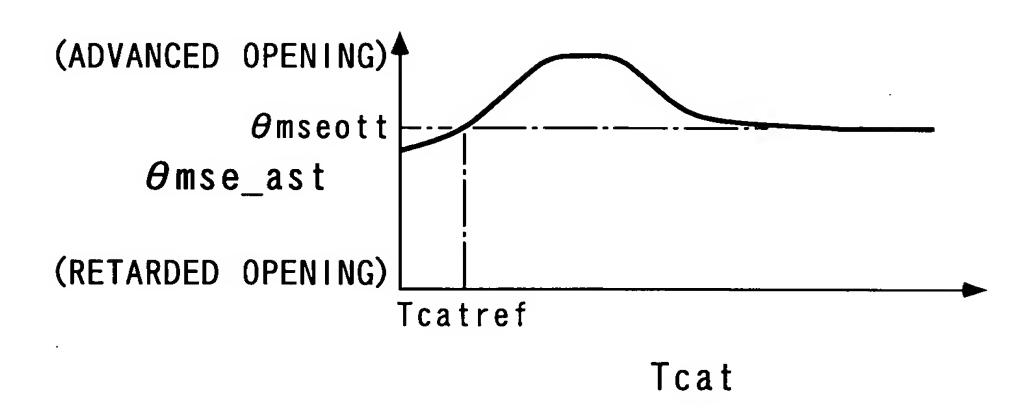
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Inventor: YASUI, et al.

H 0 3 - 1 2 6 8

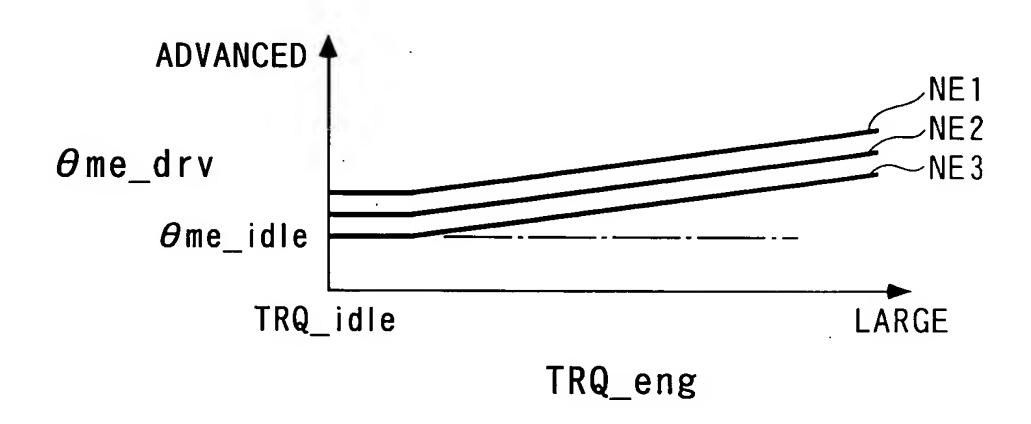
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Docket No.: 108419-00076

(4 9 / 5 4)

FIG. 60



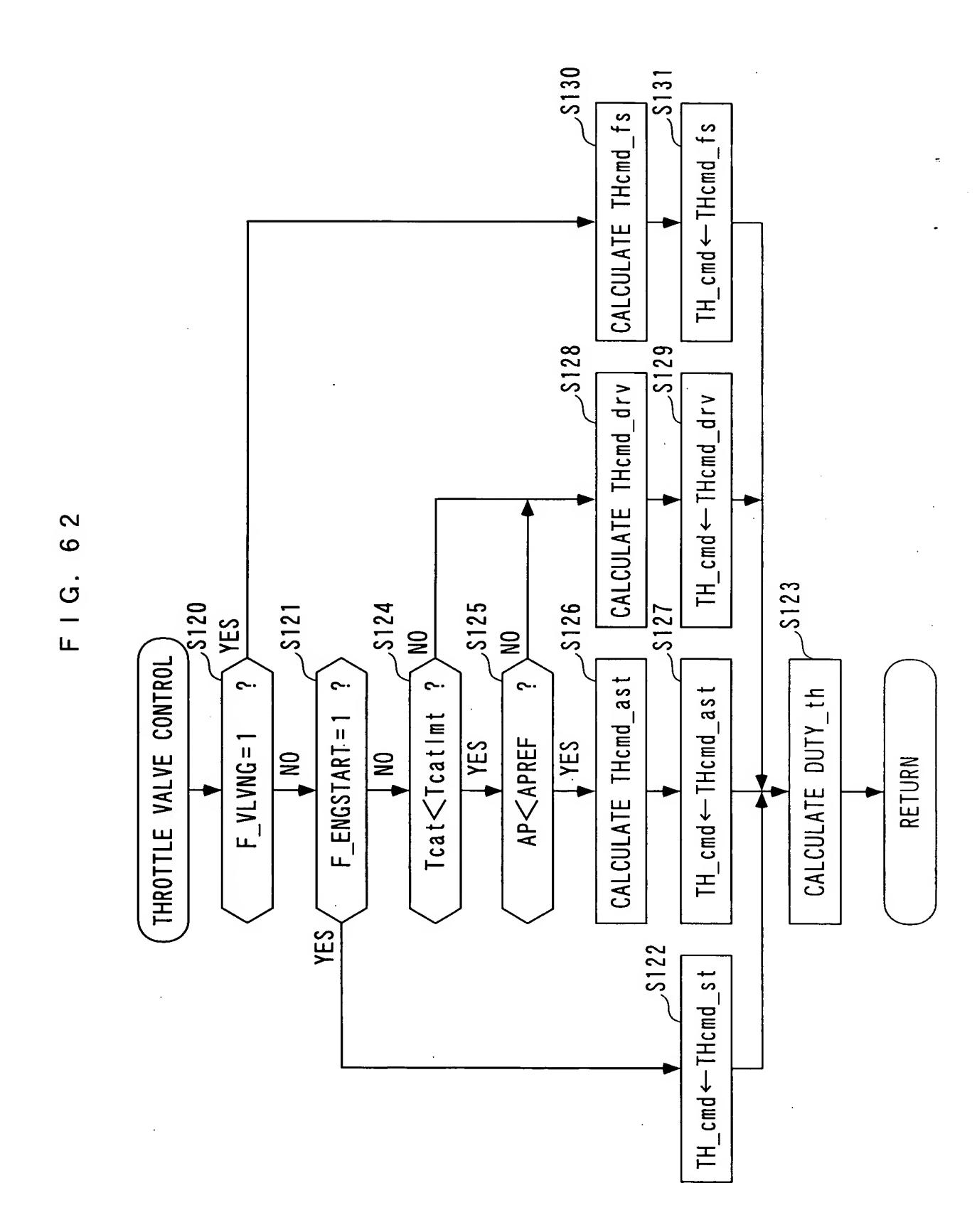
F I G. 61



H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(50/54)



(51/54)

H 0 3 - 1 2 6 8

F I G. 63

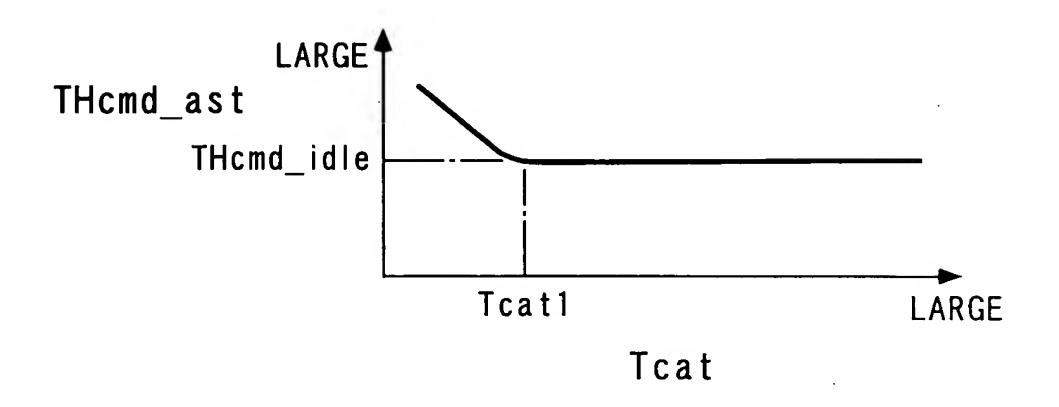
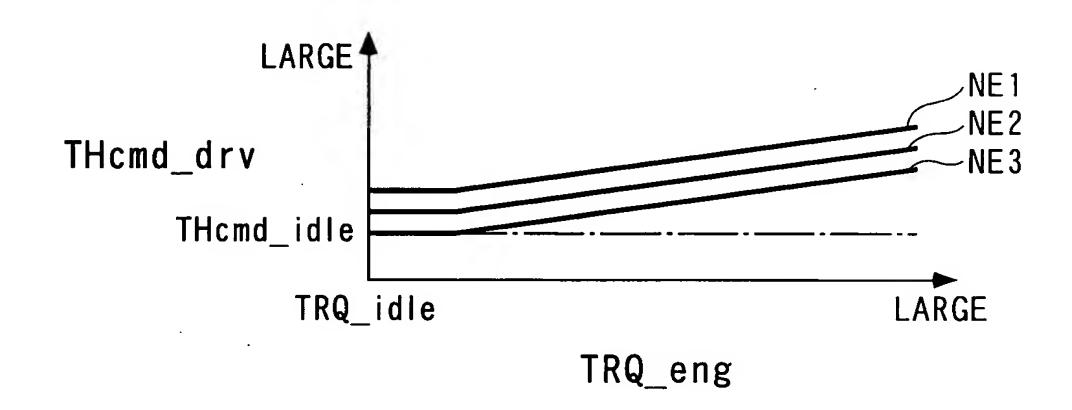
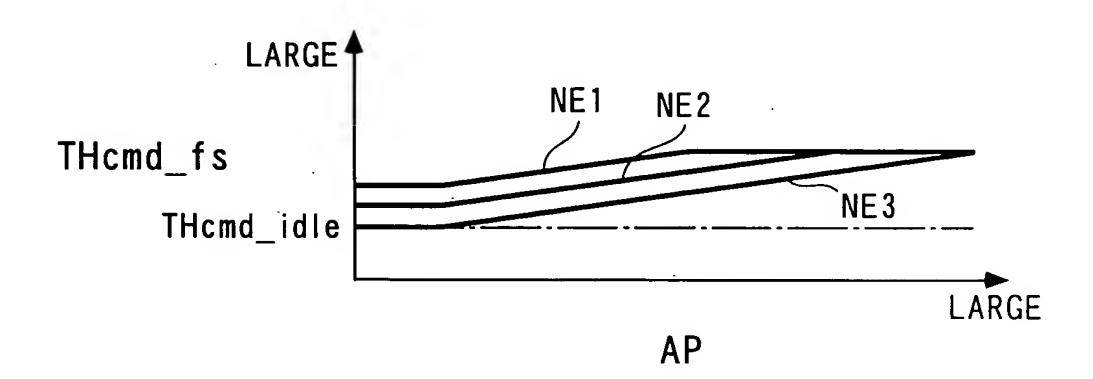


FIG. 64



F I G. 65

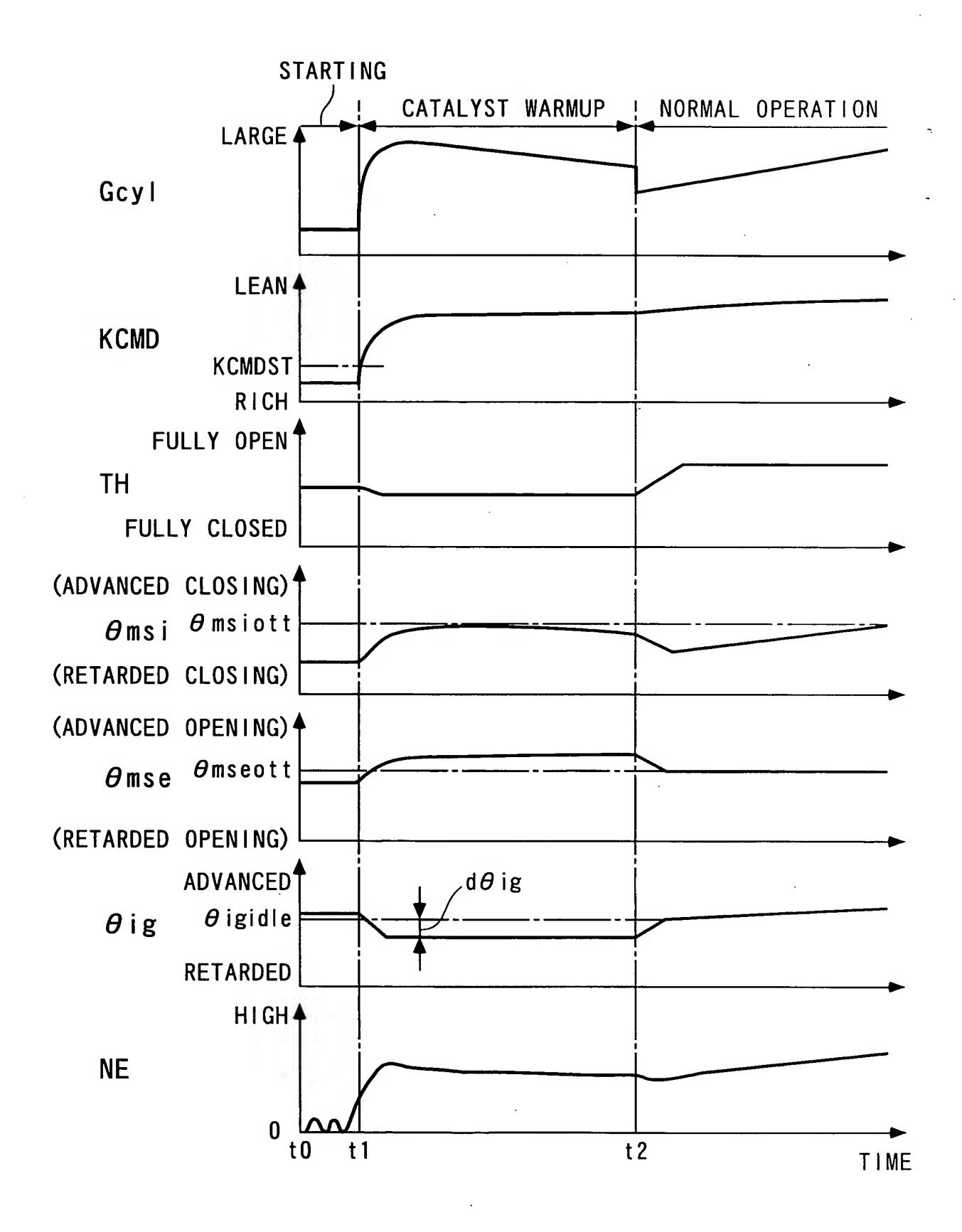


H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(52/54)

FIG. 66



Internal IComnbustion Engine and Control

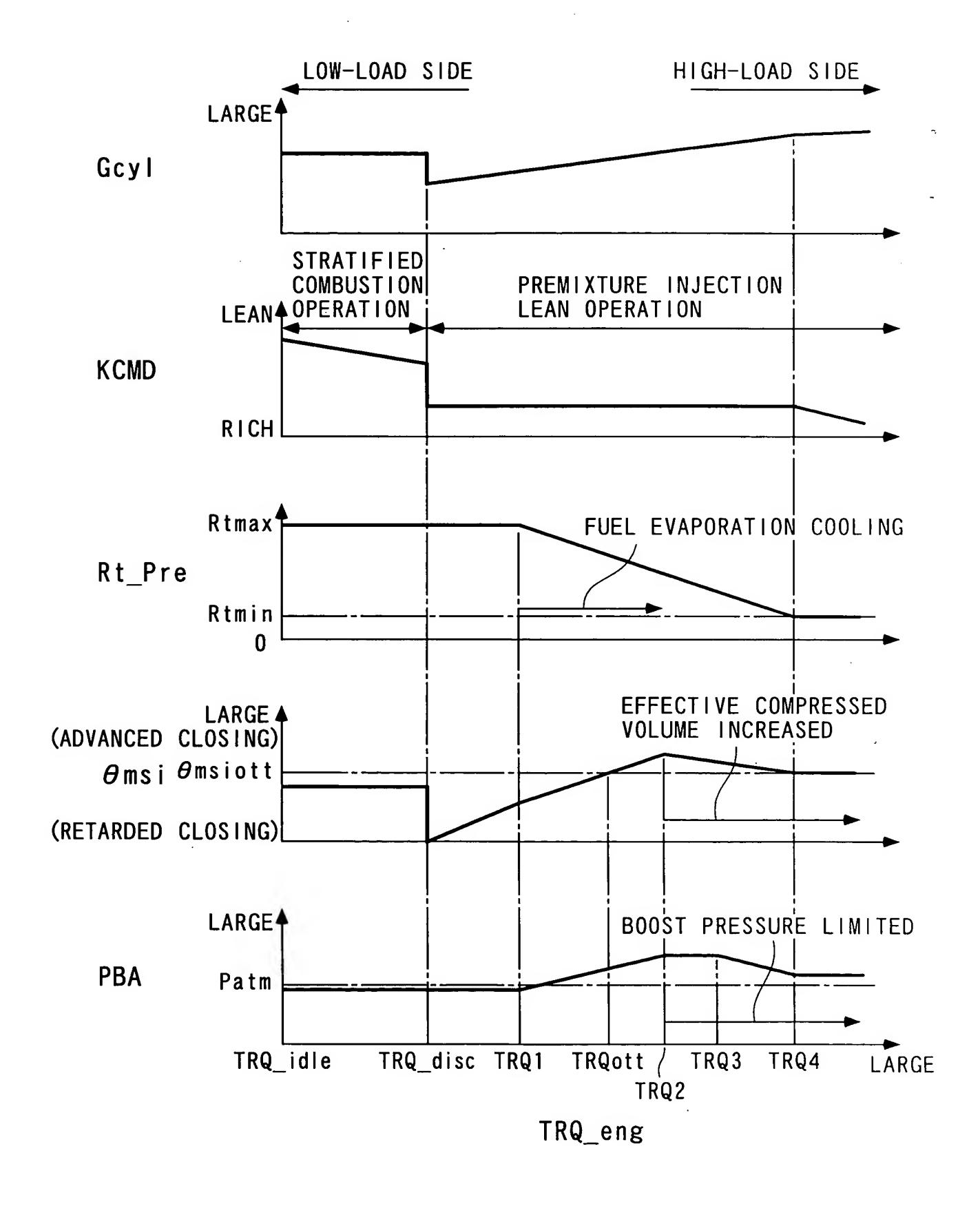
System

H03-1268

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(53/54)

F | G. 67



H 0 3 - 1 2 6 8

Inventor: YASUI, et al. Appln. No.: New Application Docket No.: 108419-00076

(54/54)

FIG. 68

